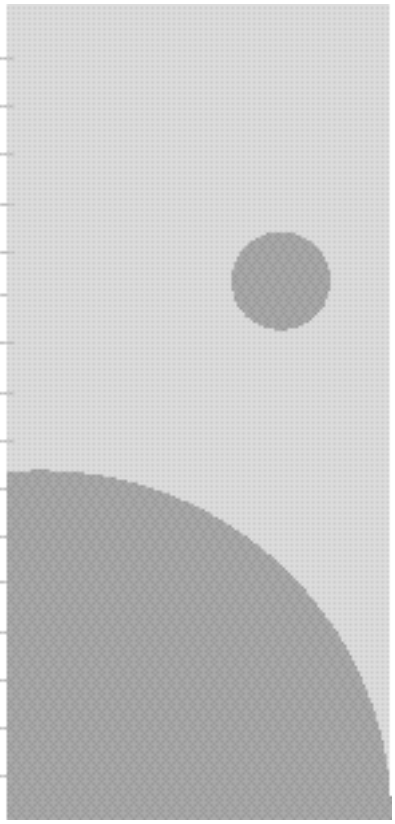
John F. Kennedy Space Center

FACTS



Foreword

This booklet is designed as a handy and quick reference for information about National Aeronautics and Space Administration (NASA) programs at John F. Kennedy Space Center (KSC). It also provides a history and brief description of the facilities and programs of Cape Canaveral Air Force Station (CCAFS).

Figures used throughout are approximate and/or rounded numbers. For more detailed information about each major facility, see descriptions listed alphabetically under geographical areas.

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Measurements

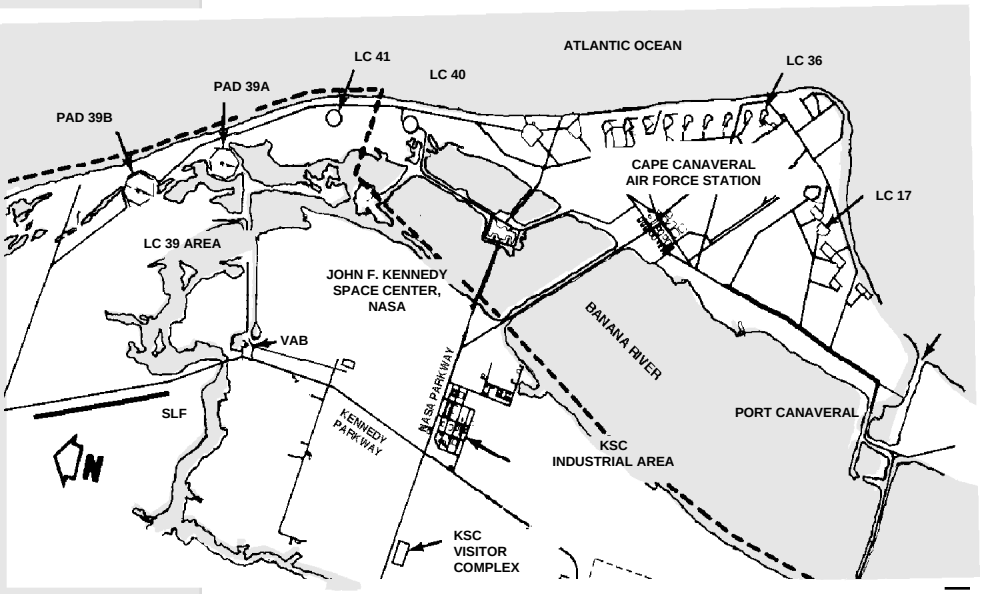
* Key to Measurement Abbreviations

acre — a
Centigrade — C
centimeter — cm
cubic foot — ft^3
cubic meter — m^3
cubic yard — yd^3
Fahrenheit — F
feet per second — ft/s
foot — ft
gallon — gal
hectare — ha
inch — in
kilogram — kg
kilometer — km
kilometers per hour — km/h
knots per hour — kn/h

Measurements

liter — L
meter — m
meters per second — m/s
metric ton — t
mile (statute) — mi
miles per hour — mi/h
nautical mile — nmi
newton — N
pound — lb
ton — ton
square foot — ft^2
square meter — m^2
square mile — mi^2

* Based on Government Printing Office style.
Same abbreviation used for singular and plural.


ATLANTIC OCEAN
LC 41
LC 40
LC 36
PAD 39A
PAD 39B
CAPE CANAVERAL
AIR FORCE STATION
LC 17
LC 39 AREA
JOHN F. KENNEDY
SPACE CENTER,
NASA
VAB
BANANA RIVER
SLF
KENNEDY
PARKWAY
NASA PARKWAY
PORT CANAVERAL
KSC
INDUSTRIAL AREA
N
KSC
VISITOR
COMPLEX

John F. Kennedy Space Center (KSC)

NASA began acquiring property in 1962 on Merritt Island for its primary launch facility, first called Merritt Island Launch Area and later John F. Kennedy Space Center. First NASA launch team was Goddard Space Flight Center's Field Projects Branch, based at Cape Canaveral Air Force Station (then called the Cape Canaveral Missile Test Annex) after NASA's formation in 1958.

First KSC employees were members of Launch Operations Center headed by Dr. Kurt Debus; also based at CCAFS prior to construction of KSC.

At KSC

- Total of approximately 56,552 ha (139,700 acres). Some 33,952 ha (83,894 a) purchased. State of Florida granted NASA right to use additional 22,600 ha (55,805 a) of state-owned submerged land. Investment in property reached approximately $71,872,000 at that time.
- Kennedy Space Center about 54.7 km (34 mi) long from north to south, and 16.1 km (10 mi) across at widest point of the Kennedy Space Center.

John F. Kennedy Space Center

Directors of the Kennedy Space Center

Kurt H. Debus	1962 - 74
Lee R. Scherer	1975 - 79
Richard G. Smith	1979 - 86
Forrest S. McCartney	1986 - 91
Robert L. Crippen	1992 - 95
Jay F. Honeycutt	1995 - 97
Roy D. Bridges Jr.	1997 - present

Space Shuttle

Space Shuttle is NASA's reusable manned space vehicle designed for transport of people, spacecraft and equipment to and from Earth orbit. Three major flight elements:

1) Orbiter about size and shape of DC-9 jet, with three reusable liquid-fueled main engines. Design life of 100 missions. Operational fleet of four first flown (in order): Columbia, OV-102, (1981); Discovery, OV-103, (1984); Atlantis, OV-104, (1985); and Endeavour, OV-105, (1992). *(Challenger, OV-099, joined fleet in 1983, and was destroyed in 1986 accident.)* The orbiters are named after

pioneering sea vessels which established new frontiers in research and exploration.

2) External tank containing liquid hydrogen and liquid oxygen for orbiter's three main engines. Only major element not recovered and reused.

3) Two solid rocket boosters (SRBs) filled with solid propellant burn in unison with orbiter's engines at liftoff. Designed for reuse on at least 20 missions.

Space Shuttle, a true aerospace vehicle, takes off like a rocket from one of two KSC launch pads, 39A and 39B. The SRBs, after exhausting propellant, separate from orbiter slightly more than 2 minutes into flight.

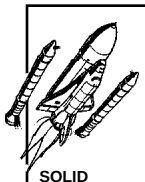
Booster casings parachute into ocean and recovered for use on future missions. External tank jettisoned after main engine cut-off, about 8-1/2 minutes after liftoff. Tank breaks up in upper atmosphere and small pieces surviving re-entry fall into remote areas of Indian or Pacific Oceans. Winged orbiter, now minus external tank and boosters, orbits Earth like spaceship during mission, then re-enters Earth's atmosphere and glides to aircraft-like landing.

KSC is NASA's processing and launch site, and prime landing location for Space Shuttle. Edwards Air Force Base (EAFB), Calif.,

is second major landing site. Alternate location, Space Harbor (formerly Northrup Strip) at White Sands, N.M., was landing site for one mission, Columbia, on STS-3 in 1982.

There are contingency landing sites at specific locations around world, on American and foreign soil, including four Trans-oceanic Abort Landing (TAL) sites, two in Africa and two in Spain: Ben Guerir Air Base, Morocco; Yundum International Airport, Banjul, The Gambia; Moron Air Base, Spain; and Zaragoza Air Base, Spain.

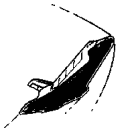
Typical Space Shuttle Mission Profile



SOLID ROCKET BOOSTER SEPARATION

Launch:	Complex 39, Pads A and B.	
Separation of solid rocket boosters:	Altitude:	47.3 km (29.4 mi)
	Velocity:	5,533 km/hr (3,438 mi/hr).
Separation of external tank:	Altitude:	118.3 km (73.5 mi)
	Velocity:	28,160 km/hr (17,498 mi/hr)
Orbit:	Altitude:	280 km (174 mi)
	Velocity:	27,876 km/hr (17,321 mi/hr)
Reentry:	Altitude:	122.3 km (76 mi)
Landing:	365 km/hr (227 mi/hr)	

EXTERNAL TANK SEPARATION



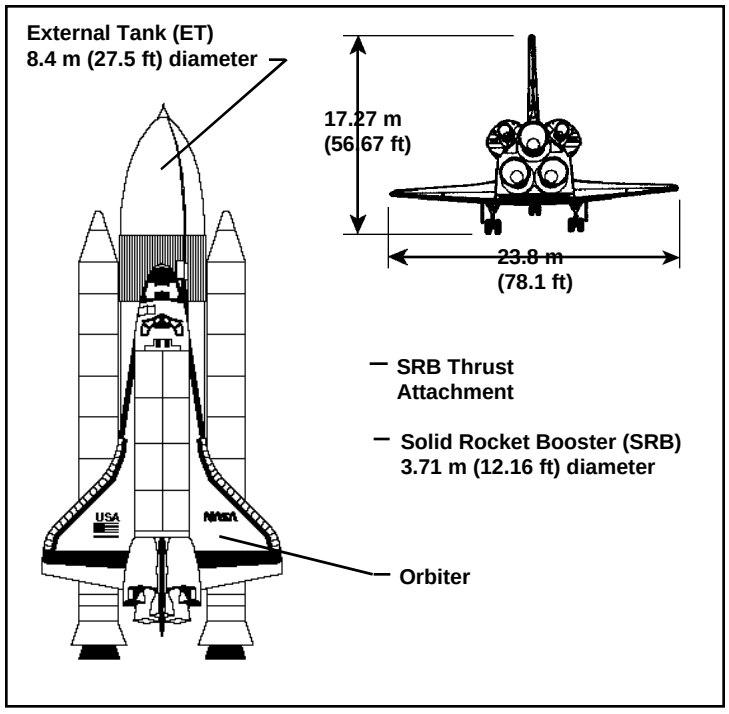
REENTRY

LIFTOFF

LANDING

Shuttle Facts

- Crew – Nominally 5 to 7 people.
- Payload weight limits – Varies, depending on many factors: landing weight constraints, altitude, orbital inclination, mission duration and rendezvous requirements. Nominal orbiter payload target weight for Space Station delivery [at an inclination from 28.8 to 57 degrees, and circular orbit of 407.7 km (220 nautical miles)], is 17,146 kg (37,800 lbs).
- Gross liftoff weight – 2 million kg (4.5 million lbs).
- Orbital altitude – Typically, 296.5 km (122-173 nautical miles); *range*, 222.4-556 km (120-300 nautical miles).
- Velocity on orbit – Typically, 7,711 m/s (25,300 ft/s), or 27,761 km/s (17,250 mi/h), at 296.5 km (160 nmi); *range,* 7,772 m/s (25,500 ft/s), or 27,980 km/h (17,386 mi/h), at 222.4 km (120 nautical miles); 7,583 m/s (24,880 ft/s), or 27,299 km/h (16,963 mi/h), at 556 km (300 nautical miles).
- Mission duration – Nominal mission, up to 18 days with extended duration orbiter (EDO) equipment; 5 to 11 days without, depending on orbital activities required.
- Total thrust at liftoff (sea level) – Estimated 31 newtons 31.131 million newtons (6,998,780 lbs 6.999 million lbs) from two solid rocket boosters and three main engines (nominally operating at 104 percent).
- Height – 56.1 m (184.2 ft).



Space Shuttle Configuration

Orbiter Processing

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Orbiter Processing

Preparing Space Shuttle orbiter for next mission begins as soon as it lands from previous flight. Convoy of vehicles and workers in position to safe orbiter when it rolls to stop on runway at either KSC or Edwards AFB in California.

If landing at KSC, orbiter towed within few hours to one of three bays of Orbiter Processing Facility (OPF) where most refurbishment and reconfiguration work takes place between missions. Of approximately 2-1/2 months required for nominal Shuttle processing, more than two-thirds of time in OPF.

If landing at EAFB, orbiter prepared for cross-country flight with special tail cone and ferry kit. Orbiter towed to Mate/Demate device for attachment to back of one of two Shuttle Carrier Aircraft (SCA), specially modified Boeing 747s. Orbiter detached from SCA at KSC Mate/Demate device at Shuttle Landing Facility and towed to OPF.

Besides routine servicing, vehicle modifications and reconfiguring orbiter for next mission takes place in OPF. Routine servicing includes safing ordnance devices; off-loading hazardous materials; reconfiguring payload accommodations; verifying systems and testing; and examination, repair and waterproofing of Thermal Protection System materials. If horizontally handled payload such as SPACEHAB is on next mission (see payload processing), payload installed before orbiter leaves OPF.

When leaving OPF, orbiter towed or placed on orbiter transporter for short trip to nearby Vehicle Assembly Building.

Orbiter mated in VAB (typically 5-day operation) to other major space vehicle elements − external tank and two solid rocket boosters − already assembled on Mobile Launcher Platform (MLP).

Completed assemblage on MLP picked up by Crawler Transporter for 5.5-km (3.4-mi) trip to Pad 39A, or 6.8-km (4.2-mi) journey to Pad 39B. Nominal time needed at pad before launch: 3 weeks.

Orbiter Statistics

- Length – 37.2 m (122 ft).
- Taxi height – 17.3 m (56.7 ft).
- Wingspan – 23.8 m (78.1 ft).
- Landing weight – Maximum, 109,771 kg (242,000 lbs).
- Main engines (3) – Thrust at liftoff (sea level): Nominally operating at 104 percent, 1.754 million newtons (394,260 lbs 394.26 thousand lbs) each, or combined total of 5,261,005 newtons (1,182,780 lbs). *Weight*, 3,175 kg (7,000 lb); *length*, 4.3 m (14 ft); *diameter*, 2.3 m (7.5 ft).
- Payload bay – *Length*, 18.3 m (60 ft); *diameter,* 4.6 m (15 ft).

Solid Rocket Booster Processing

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Solid Rocket Booster (SRB) Processing

Following Shuttle launch, expended SRBs drop by parachute into ocean. Two waiting NASA recovery ships pick them up and tow them back to Hangar AF, CCAFS, for disassembly and initial cleaning.

Four empty propellant-carrying segments transferred to rail yard, south of VAB, for installation into railroad cars for shipment to manufacturer for propellant reloading.

Remaining inert SRB components ¾ aft and forward skirts, frustums, recovery systems, electronics and instrumentation components, and elements of thrust vector control system ¾ are reconditioned at *Hangar AF* and taken to Solid Rocket Booster *Assembly and Refurbishment Facility (ARF)*, at Schwartz and Contractor Roads, for assembly and testing.

Rotation/Processing Building receives reloaded SRB segments by rail from manufacturer; includes aft, aft center, forward and forward center segments. Aft skirt assemblies integrated with booster aft segments. Segments stored at two nearby *SURGE buildings* until transferred to VAB for stacking.

Parachutes brought to *Parachute Refurbishment Facility* in KSC Industrial Area for washing, drying, repairing and re-packing in canisters for reuse. Installed in SRB forward assemblies in ARF.

SRB elements integrated into complete flight-ready sets in VAB. Each SRB aft skirt attached to MLP by four stud bolts, with explosive nuts that separate at SRB ignition.

SRB Statistics

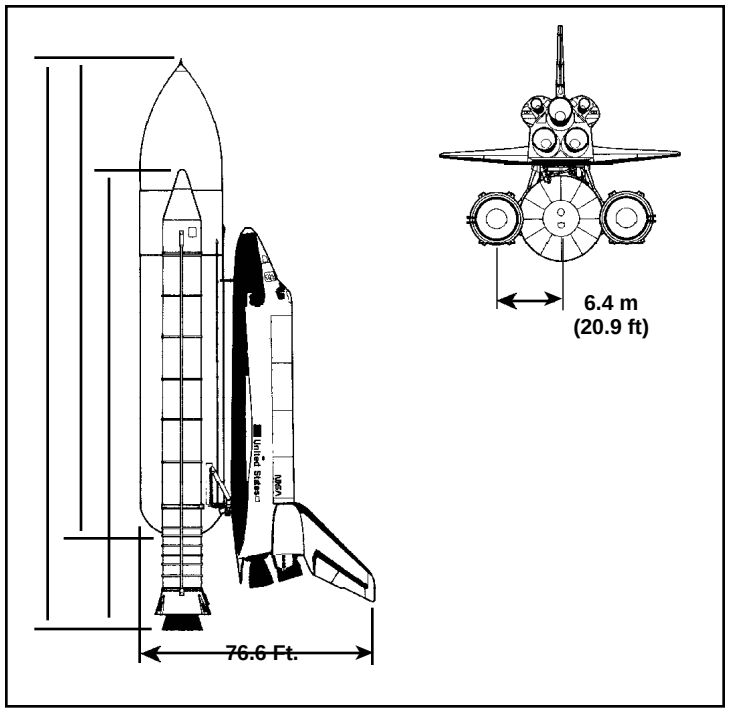
- Length – 45.5 m (149.2 ft).
- Diameter – 3.7 m (12.2 ft).
- Total redesigned solid rocket motor (RSRM) weight, including hardware, liner, igniter, nozzle, misc. – 6.3 million kg (1.38 million lbs).
- Recovery weight (each) – Approx. 84,370 kg (186,000 lbs).
- SRB (2) liftoff thrust – 12.935 million newtons (2.908 million lbs) each at sea level within 0.7 seconds after ignition, or combined total of 25.870 million newtons (5.816 million lbs). Maximum thrust of about 27.311 million newtons (6.14 million lbs) approx. 20 seconds after launch.

External Tank (ET) Processing

External tank forms structural backbone of Space Shuttle; two solid rocket boosters and orbiter attached only to external tank, not each other.

Manufactured at Michoud Assembly Facility, New Orleans, La., with oversight by NASA's Marshall Space Flight Center; shipped on transporter by barge to turn basin across Saturn Causeway from VAB; moved to nearby VAB; stored in checkout cells until needed.

- Purpose: Carries about 1,892,500 L (500,000 gal) of liquid hydrogen (fuel) and liquid oxygen (oxidizer) for three main engines. Inside ET is large liquid hydrogen tank holding about 1,449,905 L (383,066 gal), and smaller liquid oxygen tank with 541,482 L (143,060 gal), connected by intertank section. These cryogenic liquids stored in large round vessels at pad; piped into ET approx. 8 hours before liftoff.
- Construction: Superlightweight Tank version of the external tank was first flown in 1998 and utilizes an aluminum-lithium alloy developed specifically for use in the ET. This alloy, in conjunction with structural design changes, allowed for a reduction of 7500 lbs in the weight of the ET. Spray-on foam insulation provides thermal protection and gives the tank its characteristic orange color.



External Tank Configuration

External Tank Statistics

- Length – 47 m (154.2 ft).
- Diameter – 8.4 m (27.5 ft).
- Liftoff weight – 745,555 kg (1,647,677 lb).
- Empty weight – 26,470 kg (58,500 lb).

Payload Processing

Shuttle payloads follow one of three functional processing flows at KSC: horizontally handled payloads installed in orbiter's payload bay while vehicle inside Orbiter Processing Facility (OPF); horizontally handled payloads inserted in orbiter payload bay at pad; and vertically processed payloads inserted in orbiter payload bay at pad. Some types of vertically handled payloads include deployable communications and scientific spacecraft. Some types of horizontally processed payloads include Space Station assembly elements and scientific payloads which remain attached to orbiter's payload bay.

Horizontal flow/Horizontal Installation: Payloads such as scientific payloads mounted on pallets are processed or handled in horizontal position in Space Station Processing Facility (SSPF) or at Operations and Checkout Building's (O&C) Assembly and Test Area.

After assembly, checkout and integration, payloads are loaded into payload canister and transferred to OPF for horizontal installation in orbiter's payload bay.

Orbiter interface verification is then performed. Returning payloads are removed from the Orbiter in OPF and deintegrated in SSPF or O&C. Biological specimens for mid-deck experiments are processed in Hangar L, Cape Canaveral Air Force Station, and installed at launch pad. An example of a payload processed in this manner is the Shuttle Radar Topography (SRTM) mission, STS-99.

Horizontal flow/Vertical Installation: Payloads such as the Space Station Assembly Elements are processed or handled usually in horizontal position in Space Station Processing Facility or at Operations and Checkout Building's Assembly and Test Area.

SPACEHAB modules are processed in the SPACEHAB facility. After assembly, checkout and integration, payloads are loaded into payload canister and transferred to Canister Rotation Facility for rotation to the vertical position. Once rotation is completed, the payload is transported to pad for vertical installation in orbiter's payload bay. Some examples of payloads processed in this manner are Hubble Space Telescope servicing missions (such as STS-103) and Multi-Purpose Logistics Modules MPLM for Space Station missions.

Vertical flow/Vertical Installation: Payloads are received, assembled and checked out in one of three KSC facilities, Space-

craft Assembly and Encapsulation Facility (SAEF-2), Payload Hazardous Servicing Facility (PHSF) or Multi-Payload Processing Facility (MPPF), all in the Industrial Area.

Hazardous operations such as explosives or propellant servicing, spin balancing and upper-stage mating operations take place at a hazardous processing facility – the SAEF-2, PHSF, or MPPF at KSC.

In the past, payloads and upper stages were then transferred to the Vertical Processing Facility (VPF) for mating and hoisted into the Vertical Payload Handling Device.

Cargo Integration Test Equipment tests are performed to verify interfaces with orbiter. Payloads are then installed into payload canister and taken by canister transporter to launch pad for vertical installation.

The canister is then lifted vertically for transfer of payload items into Payload Changeout Room, using Payload Ground Handling Mechanism. The payload is later transferred to orbiter's payload bay. Final interface verification testing, ordnance connections and close-outs for flight are performed.

An example of a recent payload processed in this manner is the Chandra X-Ray Observatory.

Canisters are serviced and rotated to the vertical or horizontal position, depending on the payload, in Canister Rotation Facility in KSC Industrial Area.

Selected Space Shuttle History Chart

Mission/ Crew	Pad	Launch/ Landing Orbiter	Remarks
STS-1 (Young, Crippen)	39A	April 12/ April 14, 1981 Columbia	First Shuttle flight, and one of four in Orbital Flight Test Program. First flight of Columbia (OV-102).
STS-2 (Engle, Truly)	39A	Nov. 12/ Nov. 14 1981 Columbia	First time manned space vehicle reflown with second crew. Remote Manipulator system (RMS) arm was operated for first time.
STS-5 (Brand, Overmeyer, Allen, Lenoir)	39A	Nov. 11/ Nov. 16, 1982 Columbia	First operational flight for Space Shuttle after completion of Orbital Flight Test Program. Four-member crew deployed two communications satellites.
STS-6 (Weitz, Bobko, Peterson, Musgrave)	39A	April 4/ April 9, 1983	First flight of second orbiter, Challenger (OV-099). First extravehicular activity (EVA) or space walk (tethered) Challenger performed by Shuttle crew.

STS-7 (Crippen, Hauck, Fabian, Ride, Thagard)	39A	June 18/ June 24 1983 Challenger	Sally K. Ride became first American woman in space.
STS-9 (Young, Shaw, Garriott, Parker, Merbold)	39A	Nov. 28/ Dec. 18, 1983 Columbia	First Spacelab mission, and first flight of payload specialists, who are not career astronauts or NASA employees. First flight of non-U.S. citizen on American-manned Lichtenberg mission.
STS-41-B (Brand, Gibson, McNair, Stewart)	39A	Feb. 3/ Feb. 11, 1984 Challenger	First untethered space walks by humans.Shuttle Pallet Satellite (SPAS) became first satellite refurbished and flown again (first flown on STS-7). First KSC landing.
STS-41-C (Crippen, Scobee, Nelson, Van Hoften, Hart)	39A	April 6/ April 13, 1984 Challenger	First direct ascent trajectory for Shuttle in which main engines propel it to operational altitude. First planned repairof orbiting satellite, the Solar Maximum Mission spacecraft.

STS-41-D (Hartsfield, Coats,Resnik, Mullane, Hawley, Walker)	39A	Aug. 30/ Sept. 5, 1984 Discovery	First flight of third orbiter, Discovery (OV-103).
STS-41-G (Crippen, McBride, Leestma, Ride, Sullivan, Garneau, Scully-Power)	39A	Oct. 5/ Oct. 13, 1984 Challenger	Kathryn D. Sullivan became first woman to walk in space. First flight of two women, Sullivan and Ride. First with seven crew members. Robert Crippen became first astronaut to fly four times on the Shuttle.
STS-51-C (Mattingly, Shriver, Buchli, Onizuka, Payton)	39A	Jan. 24/ Jan. 27, 1985 Discovery	First mission dedicated to Department of Defense. Inertial Upper Stage (IUS) booster deployed.
STS-51-J (Bobko, Grabe, Stewart, Hilmers, Pailes)	39A	Oct. 3/ Oct. 7, 1985 Atlantis	First flight of fourth orbiter, Atlantis (OV-104).

STS-51-L (Scobee, Smith, Resnik, Onizuka, McNair, McAuliffe, Jarvis)	39B	Jan. 28, 1986 Challenger	Just under 74 seconds after liftoff, an explosion due to a leaky solid rocket booster claimed Challenger and its crew, including teacher Christa McAuliffe, first passenger-observer in U.S. manned space program.
STS-26 (Hauck, Covey, Lounge, Hilmers, Nelson)	39B	Sept. 29/ Oct. 3, 1988 Discovery	First mission since 51-L explosion 32 months earlier. This return-to-flight mission represented hundreds of changes in procedures and hardware.
STS-30 (Walker, Grabe, Thagard, Cleave, Lee)	39B	May 4/ May 8, 1989 Atlantis	First American planetary mission in 11 years, and first Shuttle flight to deploy a planetary spacecraft, the Magellan/ Venus radar mapper spacecraft and attached IUS.
STS-34 (Williams, McCulley, Baker, Chang-Diaz, Lucid)	39B	Oct. 18/ Oct. 23, 1989 Atlantis	Deployment of Jupiter-bound Galileo spacecraft to make first extended observations of Jovian system and first direct sampling of Jupiter’s atmo sphere, as well as first asteroid flybys.

STS-31 (Shriver, Bolden, Hawley, Sullivan, McCandless)	39B	April 24/ April 29, 1990 Discovery	Deployment of Hubble Space Telescope, first of NASA's four Great Observatories.
STS-41 (Richards, Cabana, Melnick, Shepherd, Akers)	39B	Oct. 6/ Oct. 10, 1990 Discovery	Deployment of Ulysses spacecraft to explore polar regions of Sun.
STS-37 (Nagel, Cameron, Apt, Godwin, Ross)	39B	April 5/ April 11, 1991 Atlantis	Deployment of the Gamma Ray Observatory, second of NASA's four Great Observatories.
STS-48 (Creighton, Reightler, Brown, Gemar, Buchli)	39A	Sept. 12/ Sept.- 18, 1991 Discovery	Deployment of the Upper Atmosphere Research Satellite (UARS), first element inNASA's Mission to Planet Earth program.

STS-49 (Brandenstein, Chilton, Melnick, Akers, Hieb, Thornton, Thuot)	39B	May 7/ May 16, 1992 Endeavour	First flight of fifth orbiter, Endeavour (OV-105). Space-walking records included four space walks, first three-person EVA, and longest space walk to date. First time crew attached a live rocket motor to an orbiting satellite, the INTELSAT VI (F-3).
STS-50 (Bowersox, Trinh, Dunbar, Meade, Baker, DeLucas)	39A	June 25/ July 9, 1992 Columbia	First Extended Duration Orbiter (EDO) mission.
STS-53 (Walker, Cabana, Voss, Bluford,Clifford)	39A	Dec. 2/ Dec. 9, 1992 Discovery	Last major (classified) military payload planned for Shuttle fleet.
STS-61 (Covey, Bowersox, Musgrave, Hoffman, Akers, Thornton, Nicollier)	39B	Dec. 1/ Dec. 13, 1993 Endeavour	First Hubble Space Telescope (HST) servicing mission. Set new record of five space walks on single mission.

STS-63 (Wetherbee, Collins, Foale, Harris Jr., Voss, Titov)	39B	Feb. 3/ Feb. 11, 1995 Discovery	First flight of female pilot (Collins); third flight of SPACEHAB.
STS-71 (Gibson, Precourt, Harbaugh, Baker, Dunbar)	39A	June 27/ July 7, 1995 Atlantis	100th U.S. human space launch conducted from Cape. First Shuttle-Mir docking. Largest spacecraft ever in orbit; first on-orbit changeout of Shuttle crew.
STS-79 (Readdy, Wilcutt, Akers, Apt, Walz)	39A	Sept. 16/ Sept. 26, 1996 Atlantis	Fourth Shuttle-Mir docking. Lucid returns from Mir after 188-day stay in space, setting new U.S. record & world record for a woman; also distinction of being member of four different flight crews – two U.S. and two Russian.
STS-80 (Cockrell, Jones, Rominger, Jernigan, Musgrave)	39B	Nov. 19/ Dec. 7, 1996 Columbia	Longest shuttle flight to date: 18 days. Musgrave set new record for most Shuttle flights (6), tying John Young's record for most spaceflights.

STS-82 (Bowersox, Horowitz, Lee, Hawley, Harbaugh, Smith, Tanner)	39A	Feb. 11/ Feb. 21, 1996 Discovery	Second Hubble Space Telescope servicing mission. Five EVAs, the last unscheduled in order to repair insulation on HST.
STS-84 (Precourt, Collins, Clervoy, Noriega, Lu, Kondakova)	39A	May 15/ May 24, 1997 Atlantis	Sixth Shuttle-Mir docking. First U.S.-Russian space walk, Linenger and Tsibliev. Small fire on Mir required crew to wear protective masks for 36 hoursuntil cabin air cleared.
STS-87 (Kregel, Lindsey, Chawla, Doi, Scott, Kadenyuk)	39B	Nov. 19/ Dec. 5, 1997 Columbia	First time in 5 years that eight flights conducted in one year and all launched on target date set in Flight Readiness Review. Doi first Japanese citizen to walk in space.
STS-90 (Searfoss, Altman, Williams, Hire, Linnehan, Buckey, Pawelczyk)	39B	April 17/ May 3, 1998 Columbia	First KSC astronaut Kay Hire. Last (16th) flight of Spacelab.

STS-91 (Precourt, Lawrence, Chang-Diaz, Gorie, Kavandi, Ryumin)	39A	June 2/ June 12, 1998 Discovery	Return of 7th and last U.S. astronaut to live and work aboard Mir. First flight of super lightweight external tank. First docking mission for Discovery.
STS-95 (Brown, Lindsey, Parazynski, Robinson, Duque, Mukai, Glenn)	39B	Oct. 29/ Nov. 7, 1998 Discovery	John Glenn makes first Shuttle flight, second spaceflight, since pioneering Mercury flight in 1962 in Friendship 7. First U.S. President (Clinton) to attend Shuttle launch.
STS-88 (Cabana, Sturckow, Currie, Ross, Newman, Krikalev)	39A	Dec. 4/ Dec. 15, 1998 Endeavour	First launch for assembly of International Space Station, connecting U.S. Unity module to Russian Zarya control module. Ross set new space walk record with 7th walk, totaling 44 hours, 9 minutes.

STS-96 (Rominger, Husband, Jernigan, Barry, Ochoa, Payette, Tokarev)	39B	May 27/ June 6, 1999 Discovery	Second International Space Station flight. First docking to Space Station. Mission included attaching equipment and tools for future missions.
STS-93 (Collins, Ashby, Hawley, Coleman, Tognini)	39B	July 23/ July 27, 1999 Columbia	First mission in Space Shuttle history to be commanded by a woman (Collins). Payload: Chandra X-ray Observatory deployed.
STS-103 (Brown, Kelly, Smith, Foale, Grunsfeld, Nicollier, Clervoy)	39B	Dec. 19/ Dec. 27, 1999 Discovery	Third Hubble Space Telescope servicing mission – three gyroscopes had failed. Three EVAs provided repairs and replacements to HST. Mission was only second time in space program that a crew spent Christmas in space.

Expendable Launch Vehicle (ELV) Program

In October 1997, NASA authorized the establishment of the Lead Center for the Acquisition and Management of the Expendable Launch Vehicle (ELV) Launch Services at Kennedy Space Center. NASA's ELV Program became active in October 1998.

The ELV Program office at KSC provides a single focus for launch services, which are acquired from commercial launch service providers. The major goal of the program is to provide highly reliable, on-time, and cost-effective launch services that meet or exceed customer requirements.

Three major enterprises form the ELV Programs major customer base:

- Space Science – missions that launch space observatories or deep space probes.
- Earth Science – missions that conduct studies of the Earth and its environments.
- Human Exploration and Development of Space (HEDS) – launches of communication satellites.

The ELV Program also supports other government users such as the National Oceanic and Atmospheric Administration (NOAA)

and foreign cooperative missions. Furthermore, it partners with other NASA centers, academia and industry in creating new technology resulting in lower cost and more reliable access to space.

The ELV office has responsibility for NASA launches at Cape Canaveral and Vandenberg Air Force Base, Calif. NASA has conducted launches from Complexes 17, 36, 41 and 46 at Cape Canaveral; and from Space Launch Complex 2 at Vandenberg, which is the primary launch site for polar orbits of the Earth.

International Space Station

The completed International Space Station will be a permanent orbiting laboratory in space capable of performing long-duration research in the unique environment of Earth's orbit. The Space Station will expand U.S. leadership of the global community, forge new partnerships with other nations for the benefit of humankind, serve as a driving force for emerging technologies, inspire our children and encourage education, foster the next generation of scientists, engineers, and entrepreneurs, and satisfy humanity's need to explore.

Aboard this international orbiting laboratory, astronauts from many nations will advance medical research, benefiting all human-

kind; develop new materials and processes to benefit industries on Earth; accelerate breakthroughs in technology and engineering that will have immediate, practical applications for life on Earth; and will create jobs and economic opportunities worldwide.

In orbit 220 miles above Earth, the Space Station will circle the globe at an inclination of 51.6 degrees to the equator. When completed, the Space Station will be 356 feet across and 290 feet long. It will weigh about 950,000 pounds. Up to seven people will live on the Space Station.

In preparation for the assembly and operation of the International Space Station, NASA and the Russian Space Agency entered into a cooperative program using the U.S. Space Shuttle and the Russian space station Mir to try out new technologies and work on procedures to decrease risk in the future. The program allowed U.S. and Russian engineers and planners to learn to overcome cultural differences and work together in the operation of a long-term spacecraft. It also permitted scientists to conduct experiments on Mir. The Shuttle-Mir program ended in May 1998.

The Space Station will provide scientists the electric power and laboratory space on orbit to conduct the research needed for safe, long-term space exploration by human beings. The knowledge gained will also benefit research on Earth in many fields. Areas of research currently planned for the International Space Station include biotechnology, materials science, combustion science,

gravitational biology, advanced human life support, Earth observation, space science, physics, and engineering research and technology.

The United States has the responsibility for developing and ultimately operating major elements and systems aboard the Space Station. The **elements** include three nodes, a laboratory module, truss segments, four solar arrays, a habitation module, a cupola, an unpressurized logistics carrier, and a centrifuge module. The first U.S. pressurized module of the Space Station, Unity, was built at Marshall Space Flight Center and outfitted at Kennedy Space Center. The first Shuttle assembly flight was to connect the U.S. Unity module to the Russian Zarya control module, already in orbit.

The **systems** include thermal control, life support, guidance, navigation and control, data handling, power systems, communications and tracking, ground operations facilities, and launch-site processing facilities.

Assembly of the International Space Station began in December 1998 on mission STS-88 and will be completed in 2004. Additional assembly flights were made in June 1999 (carrying tools and equipment) and April 2000 (SPACEHAB). Future flights planned were STS-92, the Z-1 truss and Pressurized Mate Adapter; STS-106, preparing the Station for long-term crew; STS-97, PV module P6; STS-98, the U.S. Laboratory Destiny; STS-102, the Leonardo Multi-Purpose Logistics Module; and STS-100, the Raffaello Multi-Purpose Logistics Module.

KSC Facilities

Kennedy Space Center divides into two major geographical areas for processing, launching and landing Space Shuttle and payloads, as well as integrating and launching space station components. They are Launch Complex 39 (plus the north area, including the Shuttle Landing Facility) and the Industrial Area, about 8 km (5 mi) south of Launch Complex 39. Description of major facilities in Industrial Area followed by description of facilities in Launch Complex 39 area.

KSC Industrial Area

Canister Rotation Facility (CRF): In Industrial Area, south of Headquarters Building on D Ave. Surface area: 907 m^2 (9,760 ft^2). Maintains two payload canisters used to move payloads between processing facilities and to launch pads. Contains 43.3 m (142 ft) tall high bay with 90.7 t (100 ton) bridge crane. Allows rotation of 19.8 m (142 ft) long payload canister to either horizontal or vertical position, depending on payload requirements. Before facility built, canister rotation was only possible in VAB. Standard servicing of canister's internal surfaces – no "clean room" work area environment.

Central Instrumentation Facility (CIF): Hub of instrumentation and data processing operations. Three stories, 12,669 m^2 (136,378 ft^2), located west of Headquarters Building. Houses offices, laboratories and test stations, including main calibration labs.

Communications Distribution and Switching Center: Located across from guard station 2B on NASA Parkway East. Facility is manned by USA Transmission & Wire Networks, Voice Systems Communications personnel. The Primary KSCB Switchboard Telephone Switch is located in the facility, maintained by SPACE MARK, INC., along with their installation personnel. This facility also contains a large dish antenna which receives and sends communications between KSC, Mission Control in Houston, NASA Headquarters and other NASA centers with ground stations, through GE American Comm GE-2 satellite.

Cryogenics Testbed Facility (CTF): Opened early 2000, 6,450 ft^2 building located at the corner of 3rd Street and E Ave. Provides state-of-the-art faciltiy for KSC to research cryogenic techniques in the fields of medicine, biology, food, computers, industry, rocket propulsion and future spaceports. The NASA and Dynacs, Inc. technical team performs a wide variety of cryogenics-related development and testing in this Cryogenics Test Laboratory. Four

technology areas include thermal insulation systems, cryogenics components, propellant process systems, and low temperature applications.

Development Testing Laboratory (also known as Prototype Shop): One-story, 1,628 m^2 (17,521 ft^2) building, located south of Launch Equipment Test Facility. Develops, fabricates and tests prototype hardware and equipment in support of all the major programs at KSC and other field centers. The Laboratory includes a weld shop, model shop, sheet metal and machine shop, electrical and electronic labs, photo lab, and instrumentation testing lab. The lab also has a state-of-the-art cryogenic and high-pressure gas test capability.

Headquarters Building: 40,824 m^2 (439,446 ft^2) administrative center for KSC, housing many contractor and NASA offices. Reinforced concrete building three stories high except for center section where fourth floor houses center director and some staff members.

Hypergol Maintenance Facility (HMF): Consists of four main buildings in Hypergol/Payload Test Area remotely located southeast of Operations & Checkout Building. Two test cells for checkout, refurbishment and revalidation of hypergolic-fueled modules of the

orbiter's Reaction Control System (RCS) and Orbital Maneuvering System (OMS). One building houses the test control room and another logistics support. In fiscal year 2001 an operations support building will be built to house shops and support personnel. One building for preparation, servicing and hot firing of solid rocket booster (SRB) aft skirt hydraulic power units.

Launch Equipment Test Facility (LETF): Located south of Operations and Checkout Building. Testing site for launch-critical ground support systems and equipment such as orbiter access arm, external tank gaseous oxygen vent arm, external tank vent line, tail service masts and umbilical systems, and SRB holddown posts. Designed to simulate launch vehicle events such as movement from wind, orbiter ignition and liftoff, effects of solar heating and cryogenic shrinkage.

Multi-Payload Processing Facility (MPPF): Located just off E Avenue south of Operations and Checkout (O&C) facility and just north of Payload Hazardous Servicing Facility (PHSF). Facility is non-hazardous and can facilitate several non-hazardous payload elements being processed simultaneously. The MPPF complex has two major structures, 1) the highbay 40.2 m (132 ft) long x 18.9 m (60 ft) wide, with ceiling height of 18.9 m (62 ft) ; lowbay 10.4 m (34 ft) long x 10.4 m (34 ft) wide with ceiling height 6.1 m (20 ft).

The highbay contains one 18.1 m (20 ton) bridge crane. The highbay's largest door opening is 8.5 m (28 ft) x 12.8 m (42 ft) and lowbay's largest door opening is 6.1 m (20 ft) wide x 4.6 m (15 ft) high. The equipment airlock is 11.9 m (39 ft) x 8.5 m (28 ft), with ceiling height of 6.1 m (20 ft), largest door opening is 6.1 m (20 ft) x 4.6 m (15 ft). Payload canister enters from east highbay door. The highbay and lowbay are classified at level 4:100,000 Clean Work Area (CWA) and airlock is classified at level 5:300,000 CWA. The MPPF has office trailers on site with office areas, control rooms and storage area at MOSB that is south of MPPF adjacent to PHSF.

Operations and Checkout Building (O&C): Five-story, largest facility in Industrial Area with 55,926 m^2(602,000 ft^2). The facility consists of offices, laboratories, astronaut crew quarters and payload assembly areas. Receiving, assembly and testing of horizontally integrated and processed payloads, including Shuttle pallet-type payloads and special flight structures. International Space Station truss segments and pressurized labs are also processed in this building. Processing activities include hardware staging, experiment integration, payload integration and verification. Cargo integrated tests are performed to verify compatibility with orbiter systems of horizontally processed payloads; several payloads can be processed simultaneously. The processing bay of O&C is a clean work area which measures 198.1 m (650 ft) long

and uniform 25.9 m (85 ft) wide except in high bay at east end where it is 11.7 m (38.5 ft) wide. The high bay area is 53.3 m (175 ft) long, 31.7 m (104 ft) high, and low bay 144.8 m (475 ft) long and 21.3 m (70 ft) high. Crew quarters for astronauts on third floor.

- *Clean work areas:* Low bay, 100,000 parts per million particles; ATM Clean Room at 50,000 parts per million; high bay area near altitude chambers, 300,000 parts per million.
- *Altitude chambers:* Located in high bay, were originally used to test environmental and life support systems on Apollo Lunar Module and Command Module; man-rated for Astronaut crews to operate flight systems during tests; chambers evacuated (except for crew) until reaching vacuum equivalent to approx. 69,960 m (200,000 ft). The “R” Altitude Chamber (west) has been re-activated with new pumps, controls and handling systems to support International Space Station processing. The station pressurized modules including ISS Airlock and U.S. Lab will be vacuum tested in chambers prior to flight.

Parachute Refurbishment Facility: One-story, 3,322 m^2 (35,758 ft^2) building located south of O&C, at intersection of E Avenue and Third Street. Pilot, drogue and main parachutes, which guide and slow descent of expended Shuttle solid rocket boosters, are received, cleaned, refurbished, packed and stored

here. Also refurbishes and packs orbiter drag and pilot chutes, and all SRB and Orbiter parachute bags. Originally built in 1964 for processing parachutes for Gemini spacecraft, and used as press office during Apollo program.

Payload Hazardous Servicing Facility (PHSF): Located off E Avenue south of O&C Building. The complex has three main structures: 1) The PHSF has two airlocks and hazardous servicing bay containing 250-ton bridge cranes and airlock contains a 15-ton bridge crane; 2) The Multi-Operations Support Building (MOSB) contains office areas, control rooms and support rooms for PHSF and MPPF; 3) The Payload Transporter storage facility can house payload transporters and payload customer storage. PHSF also has fuel transfer building, an oxidizer shed and krypton storage building. The PHSF is designed to accommodate variety of NASA and NASA customer payloads, both hazardous and non-hazardous. The facility is 1,717 m^2 (18,486 ft^2). The hazardous service bay is 32.6 m (107 ft) long x 18.4 m (60 ft 4 in) wide, largest door opening is 10.8 m x 22.9 m (35 ft 5 in x 75 ft) and ceiling height is 29 m (94 ft 10 in). The two airlocks are 1) equipment airlock 8 m (26 ft 1 in) long x 4.4 m (14 ft 4 in) wide, largest door opening is 3.1 m x 3.1 m (10 ft x 10 ft) and ceiling height is 32.2 m (10 ft x 4 in), 2) Airlock 25.9 m (85 ft) long x 15.3 m (50 ft 4 in) wide, largest door opening 10.8 m x 22.9 m (35 ft 5 in x 75 ft), ceiling height 27.4 m (89 ft 10 in).

The service bay is level four: 100,000 CWA and Airlock is level five: 300,00 CWA. The airlock is large enough to accommodate payload canister.

Radioisotope Thermoelectric Generator (RTG) Storage Building: Located just east of Vertical Processing Facility. Staging, testing and monitoring of radioactive devices including RTGs (used on Galileo and Ulysses spacecraft) and Radioisotope Heater Units conducted here. Also, storage of payload ordnance devices. The RTG-F has five rooms, four are storage areas and one is a mechanical room. The sizes of the rooms vary. The facility is equipped with one dual 4.5-metric (5-ton) independently operated, critical lift-category hoists mounted on single trolley and bridge. This is highly secured facility when RTGs are present.

Spacecraft Assembly and Encapsulation Facility 2 (SAEF-2): Assembly, testing and encapsulation of spacecraft, particularly for processing of heavy and large payloads. Class 100,000 CWA. 1,588 m^2 (17,098 ft^2). Located adjacent to Hypergol Maintenance Facility. Includes airlock, high bay, two low bays, test cell, control room, office areas and mechanical equipment rooms.

Space Station Processing Facility (SSPF): The SSPF is the largest new building project at KSC since Apollo era. Three-story structure located in KSC Industrial Area immediately east of O&C Building. SSPF is primary facility at KSC used to support pre-launch and post-landing processing of horizontal, non-hazardous International Space Station elements, payloads and experiments. The SSPF also supports NASA non-station payloads. The 457,000 ft^2 facility consists of six basic areas to include an airlock, intermediate and high bay areas, off-line laboratories, test, control and monitoring areas, service/support areas and administrative areas. The intermediate bay, high bay, airlock and hardware inspection areas are all Class 100,000 CWA.

Vertical Processing Facility (VPF): Processes and integrates vertical payloads and upper stages. 2,503 m^2 (26,940 ft^2) building located in southeast corner of Hypergol/Payload Test Area. Contains Cargo Integration Test Equipment (CITE) for verification of orbiter/payload interfaces. Environmentally controlled Class 100,000 CWA high bay and airlock. High bay ceiling 32 m (105 ft) with usable floor space of 943 m^2 (10,153 ft^2). Two bridge cranes with combined lift capacity of 31.7 t (35 tons). Monorail crane of 0.1 t (10 tons) services airlock. Six fixed platforms for spacecraft handling serviced by 1.8 t (2 ton) hoist.

Launch Complex (LC) 39 Area

Crawlerway: Route taken by Crawler Transporter to bring Shuttle to pad and return Mobile Launcher Platform after launch.

- *Length*: VAB to Pad 39A - 5.5 km (3.4 mi); to Pad 39B - 6.8 km (4.2 mi).
- *Width*: Overall, 39.6 m (130 ft) about the size of 8-lane freeway. Consists of two 12.2 m (40 ft) wide gravel-topped lanes, separated by 15.2 m (50 ft) wide grassy median strip.
- *Depth*: Specially constructed with four layers to support millions of pounds. In descending order, top layer of river gravel, 20.3 cm (8 in) thick on curves and 10.2 cm (4 in) on straightaway sections; 1.2 m (4 ft) of graded, crushed stone; 0.76 m (2.5 ft) of select fill; and 0.30 m (1 ft) of compact fill.

Joint Communications Control Center (JCCC): Research Planning Inc. (RPI) provides support with the JCCC. The JCCC provides 911 services to Kennedy Space Center and Cape Canaveral Air Force Station. Fire, EMS and Security response teams are supported through the monitoring of various alarm systems, communication support and the processing of 911 and administrative calls. During emergency responses, the JCCC provides real-time communication support to On-Scene Command-

ers connecting them with federal, state and local emergency response authorities.

Launch Control Center (LCC): Four-story building, 22,138 m^2 (238,304 ft^2), considered “brain” of LC 39. Elevated, enclosed bridge connects it to east side of VAB. Three firing rooms, each equipped with automated, computer-controlled Launch Processing System (LPS) for monitoring and controlling Shuttle assembly, checkout and launch operations, as well as work order control and scheduling. The fourth Firing Room is being reconfigured for the development of an Operations Control Room (OCR) for the Checkout and Launch Control System (CLCS).

- *Launch Processing System:* Three current subsystems: Checkout, Control and Monitor Subsystem (CCMS), Shuttle Data Center (SDC), and Record and Playback Subsystem (RPS). CLCS will be an updated version of CCMS.

Launch Pads 39A and 39B: Site of all Space Shuttle launches and 17 Saturn V or Saturn 1B manned and unmanned launches in Apollo, Skylab and Apollo-Soyuz Test Project programs (see also Launch Complexes 34, 37 under Cape Canaveral Air Force Station). Extensively modified for Shuttle. Initial 24 Shuttle launches from Pad A; 51-L first from Pad B.

- *Size and location:* Virtually identical, Pads A and B roughly octagonal, covering 0.65 km^2 (0.25 mi^2); 2,657 m (8,716 ft) between pads. Hardstand in pad center, 119 x 99 m (390 x 325 ft), 52,020 m^3 (68,000 yd^3) concrete; 5 percent grade to hardstand. Above sea level: Pad A, 14.6 m (48 ft); Pad B, 16.8 m (55 ft). Distance from VAB: Pad A, 5,535 m (18,159 ft); Pad B, 6,827.5 m (22,400 ft).
- *Flame Trench and Deflector System:* Trench, concrete and refractory brick, 12.8 m (42 ft) deep, 137.2 m (450 ft) long, 17.7 m (58 ft) wide. Deflector system, inverted V-shaped steel structure, deflects flames from engines and SRBs; also two movable deflectors for SRBs.
- *Sound Suppression Water System:* Tank 88.4 m (290 ft) high, capacity 1,135,500 L (300,000 gal); up to another 378,500 L (100,000 gal) in underground pipes. At 16 seconds before liftoff, water flow starts, including six 3.6 m - (12-ft) - high MLP nozzles called “rainbirds.” Protects orbiter and payloads from damage from reflected acoustical energy during liftoff. Peak flow rate: 3,406,500 L(900,000 gal) per minute 9 seconds after liftoff. Acoustical level on hardstand reduced to about 180 decibels.
- *Pedestals:* Six permanent and four extensible. Dynamic loads at rebound 3,175,200 kg (7 million lb) to 4,762,800 kg

(10.5 million lb) at liftoff. Lighting: Five clusters (40) of Xenon high-intensity searchlights positioned around perimeter to support launch.

- *Fixed Service Structure (FSS):* About 149 m^2 (1600 ft^2) per floor, 12 floors; height from pad surface, 105.8 m (347 ft) to top of 24.4 m (80 ft) lightning mast. Three service arms:
  - Orbiter Access Arm for personnel access to crew compartment through white room (holds six persons), 44.8 m (147 ft) level, extended until 7 minutes, 24 seconds before launch as emergency escape route.
  - External Tank (ET) Hydrogen Vent Umbilical and Intertank Access Arm for access to tank, hydrogen venting and mating of ET umbilicals to pad, 50.9 m (167 ft) level, arm retracted usually at T-5 days after umbilical/vent line mating, and vent line disconnected from vehicle at first motion.
  - External Tank Gaseous Oxygen Vent Arm, between 63.1 m (207 ft) and 69.2 m (227 ft) levels, with attached vent hood or “beanie cap” to heat ET’s liquid oxygen vent system to prevent ice formation, retracted at 2 minutes, 30 seconds before launch (25-second procedure).

- *Rotating Service Structure (RSS):* 31.1 m (102 ft) long, 15.2 m (50 ft) wide, 39.6 m (130 ft) high. Height from pad surface: 57.6 m (189 ft). Protects orbiter, and provides access to cargo bay for installation and servicing of payloads at pad. Five levels of access platforms. RSS rotates 120 degrees on track so its environmentally clean Payload Changeout Room fits flush with orbiter's cargo bay. RSS includes:
  - Orbiter Midbody Umbilical Unit: Access and servicing of orbiter mid-fuselage area. Liquid oxygen and liquid hydrogen for fuel cells, and some gases feed through unit.
  - Hypergolic Umbilical System: Carries hypergolic fuel and oxidizer, helium and nitrogen service lines, from FSS to Shuttle. Serves orbiter's Orbital Maneuvering System (OMS) pods and Reaction Control System (RCS).
- *Emergency Egress System:* Personnel escape route until final 30 seconds of countdown. Baskets suspended from seven slidewires extending from FSS to landing zone 365.8 m (1,200 ft) to west, with bunker. Ride: about 88.5 km/h (55 mi/h) per hour, 30-35 seconds.
- *Propellant Storage Facilities:* Tanks located on two opposite ends of pad hold liquid oxygen (oxidizer) and liquid hydrogen (fuel) to fill ET for orbiter's three main engines. 3,217,250 L (800,000 gal) tank, northwest corner, holds liquid oxygen at

less than minus 148 degrees C (minus 298 degrees F); 3,217,250 L (850,000 gal) tank, northeast corner, contains liquid hydrogen at minus 217 degrees C (minus 423 degrees F). Hypergolic propellants (monomethyl hydrazine and nitrogen tetroxide) also stored in 10,000-gallon tanks for OMS and RCS.

- *Weather Protection System:* Protects orbiter tiles from rain, hail and wind-blown debris. RSS is primary protection. System includes metal sliding doors between orbiter's belly and ET, connected to RSS and FSS, protecting orbiter's lower portion; inflatable seal shielding top of orbiter, extending from Payload Changeout Room (PCR), forming a semicircle covering 90 degrees of arc between vehicle and ET; series of bifold metal doors fold out from PCR to cover side areas between ET and orbiter.
- *Pad Terminal Connection Room:* Reinforced concrete room, west side of flame trench, underneath elevated hardstand. Equipment links Shuttle, MLP and pad with Launch Processing System in Launch Control Center.

Logistics Facility: Located south of VAB on Contractors Road. Main building 21,351 m^2 (229,825 ft^2). Built in 1985 to consolidate logistics functions near processing area. Automated storage and retrieval system.

Operations Support Building (OSB): Six-story, 27,684 m^2 (298,000 ft^2) office building dedicated in 1990. Includes technical documentation center, library and photo analysis area.

Orbiter Processing Facility (OPF): Three bays permitting processing of three orbiters in parallel like sophisticated airplane hangars. Primary processing tasks include previous mission payload reconfiguration/installation. High Bays 1 and 2 connected by low bay and located west of VAB. High Bay 3 (formerly Orbiter Modification and Refurbishment Facility) is separate building northwest of VAB, northeast of Bays 1 and 2. High bay dimensions: 60 m (197 ft) long, 46 m (150 ft) wide and 29 m (95 ft) high; 2,694 m^2 (29,000 ft^2) area. Low bay: 71 m (233 ft) long, 29.6 m (97 ft) wide, 7.5 m (24.6 ft) high. Each high bay has two 27.2 t (30-ton) bridge cranes, hook height of 20.1 m (66 ft).

Press Site: Primary site for news media activities at KSC. On elevated area south of VAB and adjacent to the Barge Terminal Facility (turn basin). Covered grandstand seats 350; one-story structure with 90-seat auditorium for press conferences and briefings, and audiovisual laboratory. Some media representatives maintain permanent facilities on land leased from NASA.

Processing Control Center (PCC): Three-story, 9,197 m^2 (99,000 ft^2) facility for LPS Software Development, launch team training and Launch Processing System (LPS) maintenance. Located between OPF Bays 1 and 2 and OSB.

Rotation/Processing Building: Located north of Vehicle Assembly Building (VAB) and Mobile Launcher Platform (MLP) parksite. Railroad tracks run through rotation building for receiving loaded Solid Rocket Motor (SRM) segments from manufacturing facility. SRM segments loaded with propellant are received, inspected and prepared for stacking in VAB. The Solid Rocket Booster (SRB) aft assembly and testing is also performed in this facility. Two surge buildings located within this facility are capable of staging one additional flight set of SRM segment each.

Shuttle Landing Facility (SLF): Designed for end-of-mission orbiter landings; post-Apollo facility located approx. 4.8 km (3 mi) northwest of VAB. Concrete landing strip longer and wider than most commercial runways, but comparable to research and development runways: 4,572 m (15,000 ft) long, plus 304.8 m (1,000 ft) paved overruns each end; 91.4 m (300 ft) wide (about length of football field), with 15.2 m (50 ft) asphalt shoulders each side; 40.6 cm (16 in) thick in center, and 38.1 cm (15 in) on sides; slope of 61 cm (24 in) from center line to edge for drainage. Single

landing strip considered two runways, depending on approach – Runway 15 from northwest, Runway 33 from southeast. Also used by other planes such as military and civilian cargo carriers, astronauts' T-38 trainers, Shuttle Training Aircraft, and helicopters.

- *First KSC orbiter landing:* Mission 41-B on Feb. 11, 1984. KSC orbiter landings put on hold twice since 1985 because of concerns about safety and runway conditions. Modifications to orbiter and SLF made; planned end-of-mission landings resumed 1991. Now considered prime orbiter landing site.
- *Parking apron:* 167.6 m x 149.3 m (550 ft x 490 ft), southeast end of runway. Mate/Demate Device (MDD), northeast corner of ramp, 45.7 m (150 ft) long, 28.3 m (93 ft) wide, 32 m (105 ft) high, lifts up to 104,328 kg (230,000 lb). MDD used to attach or lift orbiter from Shuttle Carrier Aircraft for ferry operations. Lightning protection-equipped.
- *Navigation and landing aids:*
  - Tactical Air Navigation (TACAN) system for range and bearing measurements when orbiter up to 44,196 m (145,000 ft) altitude.
  - Microwave Scanning Beam Landing System (MSBLS) for more precise guidance signals on slant range, azimuth

and elevation when orbiter up to 5,486.4 m to 6,096 m (18,000 ft - 20,000 ft). (MSBLS autoland capability can guide orbiter to “hands off” landing if necessary).

– Special Category 1 Differential Global Positioning Satellite SCAT-1 (DGPS) Landing system for future GPS-equipped vehicles.
– Precision Approach Path Indicator (PAPI) lights at 2,286 m (7,500 ft) and 1,981.2 m (6,500 ft), electronic visual system to show pilots whether they are on correct glide slope.
– Ball-Bar light system, visual reference for inner glide slope. 24 red lamps in horizontal sets of four each (bar), located 670.6 m (2,200 ft) from runway threshold, 91.4 m (300 ft) from first nominal touchdown point; three white lights (ball), 152.4 m (500 ft) closer to runway threshold at higher elevation.
– Lighted distance-remaining markers show distance to end of runway. Touchdown nominally 762 m to 823 m (2,500 to 2,700 ft) beyond runway threshold.
– Xenon lights, for night landings. Each of 16 lights produce up to 1 billion candlepower. Eight lights in two groups of four at each end of runway. To avoid blinding crew, the

lights illuminated only at end of runway that will be behind landing orbiter.

- *Orbiter touchdown speed:* 343 to 364 km/h (213 to 226 mi/h).
- *Bird hazard:* With more than 330 native and migratory bird species at KSC, birds present special hazard to landing orbiter. Selective grass cutting, pyrotechnic and noise-making devices used to discourage birds around runways.
- *Control tower:* East of runway and south of midpoint. Provides positive control of all local flights and ground traffic. Controls support aircraft for shuttle launch and end of mission, including DOD and NASA helicopters for security, medical evacuation and rescue, as well as NASA weather assessment aircraft.
- *Orbiter recovery convoy staging area:* East of runway at midpoint. 20 to 30 specially designed vehicles or units respond from here to safe orbiter, assist in crew departure, and tow vehicle to processing facilities. Orbiter responsibility handed from JSC to KSC after vehicle cool-down and crew departure, usually within hour after touchdown.
- *Press and guest viewing areas:* On mound east of convoy area, entrance from Sharkey Road. Separate press and guest areas, bleachers and platforms, NASA Public Affairs operations building.

Solid Rocket Booster Assembly and Refurbishment Facility (ARF): 18.2 ha (45 a) complex located south of Logistics Facility on corner of Schwartz and Contractors Roads. Managed by Marshall Space Flight Center. Assembles and tests inert or non-propellant SRB elements including forward skirt, aft skirt, frustum, nose cap, thrust vector controls, recovery systems, electronic controls and associated hardware. Explosive devices for booster separation installed in ordnance area. Seven buildings: Engineering and Administration, Manufacturing, Service, Hot Fire Test, Multi-Purpose Storage Facility, Modular Office Building and Chiller Building. Three-story Manufacturing Building includes ordnance area for installation of explosive devices for booster separation. Automated checkout system, 24.4 m x 61 m (80 ft x 200 ft) high bay, two 13.6 t (15 ton) bridge cranes and two overhead gantry industrial robots, among world's largest, for spraying on insulation and inspecting SRB elements; 100,000-rated CWA for buildup of aft-skirt Thurst Vector Control (TVC) system.

Space Shuttle Main Engine Processing Facility (SSMEPF): Facility completed in June 1998 as 34,600 sq ft^2 additon to Orbiter Processing Facility No. 3. Provides space to increase capacity and efficiency of Space Shuttle Main Engine Operations. Includes low bay with six vertical engine stands, 10-ton crane and full capacity of fluids, pneunmatics and avionics to test and check main engines.

High bay with 15-ton crane, drying cells, pump room, ground support equipment storage and workshop.

Thermal Protection System Facility (TPF): Two-story, 4,088 m^2 (44,000 ft^2) facility located across Towway road from Orbiter Processing Facility Bays 1 and 2. The TPF is primary source of replacement parts for both internal and external insulation products for orbiters. Tiles, thermal barriers (high temperature flexible seals), gap fillers and ceramic insulation blankets are primary external insulation products. These components cover entire exterior of vehicle and are used to protect aluminum and graphite epoxy skin of orbiter from extreme cold (-200 degrees F, -129 degrees C) of space to extreme heat (+2900 degrees F, 1593 degrees C) of reentry. The facility is also equipped to make and repair all Thermal Control System (TCS) Blankets that line payload bay and protect orbiter midbody mechanical and fluid systems from extreme solar radiation encountered when vehicle is on orbit. Complete manufacturing of tiles from base raw material begun in 1994. Amounts vary slightly, but each orbiter has about 24,000 tiles, 2300 Flexible Insulation Blankets (FIBs), 5500 TCS Blankets, 800 thermal barriers and thousands of gap fillers.

Vehicle Assembly Building (VAB): Largest building at KSC, located off Saturn Causeway in the heart of Launch Complex 39 (LC 39) area. Built in 1960s for 110.6 m (363 ft) tall Apollo/Saturn V

vehicles; modified for Space Shuttle. Integration and stacking of complete Space Shuttle vehicle (orbiter, two solid rocket boosters and external tank) takes place on Mobile Launcher Platform (MLP) in High Bays 1 or 3, facing east. External tank checkout and storage in High Bays 2 and 4, facing west. The modification of High Bay 2 for Safe Haven of Space Shuttle vehicles returning from Pad 39A or 39B during hurricane conditions began late 1999 and continued into 2000. Final completion of the modification was achieved in May 2000, prior to start of hurricane season. High Bay 4's modification is for storage of an orbiter vehicle on ground floor if launch manifest has all four orbiter vehicles at KSC without one being mated to Solid Rocket Motors and External Tank on MLP. Low bay cells are holding area for solid rocket booster forward assemblies. North-south transfer aisle transects and connects two bay areas.

One of world's largest buildings by volume (reportedly was largest when built). Encloses 3,666,930 m^3 (129,482,000 ft^3) of space. VAB covers 3.2 ha (8 a); 160 m (525 ft) tall, 218 m (716 ft) long – more than two football fields – 158 m (518 ft) wide.

- *American flag:* 63.7 m x 33.5 m (209 ft x 110 ft).
- *High bay doors*: 4, each 139 m (456 ft) high, shaped like inverted "T." Low door section 46.3 m (152 ft) wide and 35 m (114 ft) high, four panels move horizontally; upper section

104.2 m (342 ft) high and 23.2 m (76 ft) wide, seven panels move vertically. About 45 minutes to open all panels.

- *Construction:* 89,421 t (98,590 tons) of steel; 49,725 m^3 (65,000 yd^3) of concrete; foundation of 4,225 steel pipe pilings 0.4 m (16 in) diameter, driven average 48.8 m (160 ft) to bedrock. Placed end-to-end, piles would extend 206 km (128 mi). Building designed to withstand winds up to 201 km/h (125 mi/h).
- *Air conditioning:* 10,204 t (11,250 tons) in nearby Chiller Facility serves VAB and other major nearby LC39 facilities.
- *Cranes:* High Bays - Total of four move east and west; two 295 t (325 ton), 14.2 m (466.5 ft) hook height; and two 227 t (250 ton), 140.8 m (462 ft) hook height. Transfer aisle - 159 t (175 ton) capacity, 50.6 m (166 ft) hook height.
- *Comparisons:* Height: VAB – 160 m (525 ft); Statue of Liberty from pedestal to torch – 93 m (305 ft). Volume: VAB — 3,666,930 m^3 (129,482,000 ft^3); Pentagon — 2,181,348 m^3 (77,025,000 ft^3); VAB equals 3-3/4 Empire State Buildings.

KSC LC 39/Payload Equipment

Crawler Transporter (CT): Large tracked vehicle transports Mobile Launcher Platform (MLP) to VAB and Shuttle on MLP to pad. Two crawlers first used in Apollo program, modified for Shuttle. Believed to be one of largest tracked vehicles in world when built in 1960s by Marion (Ohio) Power Shovel Co.

- *Weight*: 2.7 million kg (6 million lb).
- *Dimensions*: 39.9 m (131 ft) long, 34.7 m (114 ft) wide, 6.1 m (20 ft) to 7.9 m (26 ft) high (adjustable) — surface about size of baseball infield. Eight tracks, each with 57 shoes or cleats. Each shoe weighs 0.9 t (1 ton), measures 228.6 cm x 45.7 cm (90 in x 18 in).
- *Power*: 16 traction motors, powered by four 1,000-kw direct current generators, driven by two 2,750-hp diesel engines. Two 750-kw alternating current generators, driven by two 1,065-hp diesel engines for jacking, steering, lighting and ventilating. Two 150-kw alternating current generators for MLP power.
- *Fuel*: Burns about 567.7 L (150 gal) of diesel per mile; or approx. 10.7 m (35 ft) per gallon. Maximum speed: about 1.6 km (1 mi) loaded; 3.2 km (2 mi) unloaded.

- *Operator cabs:* Two, located at each end of chassis diagonally across from each other. Provide steering angle and speed control. CT can move forwards and backwards, and negotiate curves of 152.4 m (500 ft) mean radius; leveling system keeps load stable, even on 5 percent grade up launch pad surface.
- *Laser docking system:* Added in 1985, enables drivers to dock CT/MLP in VAB and at pads within 1.3 m to 0.6 cm (0.50 in to 0.25 in) of fixed - dead zero - position.

Mobile Launcher Platform (MLP): Platform on which Space Shuttle is assembled and from which it is launched. Three built for Apollo/Saturn program (called Mobile Launchers) and modified for Shuttle; segments of former umbilical towers removed from MLPs now part of pads' Fixed Service Structure.

- *Weight*: Approx. 3.73 million kg (8.23 million lb); with unfueled Shuttle, 5 million kg (11 million lb); with fueled Shuttle, 6.22 million kg (13.72 million lb).
- *Size*: Two-story steel structure, 7.6 m (25 ft) high, 48.8 m (160 ft) long, 41.1 m (135 ft) wide.
- *Supports*: Positioned on six steel pedestals 6.7 m (22 ft) high when in VAB or at pad. At pad, four extensible columns stiffen MLP against rebound loads, in case of main engine

cut-off. Eight attach posts, four on aft skirt of each SRB, support and hold Shuttle on MLP; fit on counterpart posts in MLP's two solid rocket booster support wells. Shuttle disconnects from MLP by explosive nuts which release giant studs linking SRB attach posts with MLP support posts.

- *Tail service masts:* Two, one on each side of main engines' exhaust hole. 4.6 m (15 ft) long, 2.7 m (9 ft) wide, 9.4 m (31 ft) high. Provides umbilical connections for fuel and oxidizer (liquid hydrogen and liquid oxygen), gases, ground electrical power and communications links.

Orbiter Transporter: Transfers flight-ready (wheels retracted) orbiters from OPF to VAB transfer aisle.

- *Dimensions and power:* 32.5 m (106.5 ft) long, up to 6.1 m (20 ft) wide (aft section), 160 cm (63 in) to 213.4 cm (87 in) high. 76 wheels on 19 axles. Powered by 335-hp diesel engine; hydraulic jacking, leveling and drive systems. Max. speed, 19.3 km/h (13 mi/h); with orbiter aboard, 5 (mi/h).
- *Weight*: 76,205 kg (168,000 lb).

Payload Canister: Payload bay-sized container to transport integrated horizontal or vertically processed payloads. Environmentally controlled atmosphere. 19.8 m (65 ft) long, 5.5 m (18 ft) wide, 5.7 m (18 ft, 7 in) high. Capacity up to 22,680 kg (50,000 lb).

Payload Canister Transporter: Two payload canister transporters are used to move payload canisters and their associated hardware. Original canisters were replaced in January 2000. Each transporter is 12-bogie wheel, 24-tire, self-propelled vehicle to carry Payload Canister in horizontal or vertical position.

- *Dimensions and power*: 19.8 m (65 ft) long, 6.7 m (22 ft) wide, with flatbed that can be lowered or raised from about 1.5 m (5 ft) to 2.1 m (7 ft). Powered by 340-hp turbo-charged diesel engine. Max. speed unloaded, 10 mi/h; loaded 5 mi/h.
- *Weight*: 61,964 kg (136,600 lb).

Solid Rocket Motor (SRM) Transporter: Moves SRM segments between Rotation/Processing and Surge Building (RPSF), the storage facilities (Surge 1 and 2) and VAB. SRM segments are delivered from Utah by railroad car to RPSF where they are unloaded.

- *Dimensions and Power:* 15.5 m (51 ft) long, 6.1 m (20 ft) wide, 160 cm - 231 cm (63 in - 91 in) tall. 48 wheels on 12 axles. Powered by 365-hp diesel engine. Hydraulic steering, lifting and drive systems. Max. crawl speed, 9.7 km/h (6 mi/h); operating speed with loaded segment, 3.2 - 4.8 km/h (2 - 3 mi/h).
- *Weight:* 92,988 kg (205,000 lb); with max. load, 280,778 kg (619,000 lb).

Other KSC Facilities/Points of Interest

MILA Spaceflight Tracking and Data Network Station: On 24.7 ha (61 a) tract 1.6 km (1 mi) west and south of Kennedy Space Center Visitor Complex. Established in 1965; served as communications link for Apollo flights. Managed by Goddard Space Flight Center, Greenbelt, Md. MILA communications services provided to Space Shuttles; expendable launch vehicles (ELVs) launched from Cape Canaveral Air Force Station; scientific Earth-orbiting satellites (for example, Hubble Space Telescope, Gamma Ray Observatory, Extreme Ultraviolet Explorer, Earth Radiation Budget Satellite, Cosmic Background Explorer); Tracking and Data Relay Satellites (TDRS) in synchronous orbit; and payloads being prepared for launch.

Railroad system: 64.4 km (40 mi) of track, 3 locomotives, approx. 60 freight cars. Connects with Florida East Coast Railway several miles north of Titusville. Transports solid rocket booster (SRB) motor segments and structures, ground support equipment and some fluids, propellants and gases. KSC delivers all rail shipments for Air Force, Army and Navy at adjacent Cape Canaveral Air Force Station (CCAFS); includes solid rocket motors for Titan program. (CCAFS has 32.2 km or 20 mi of track.) KSC Railroad Equipment

Shop on Contractor Road maintains KSC railroad equipment and performs work for outside agencies on time-available basis.

Kennedy Space Center Visitor Complex (KSCVC): Situated on NASA Causeway West, between KSC Industrial Area and Indian River. Operated under concession agreement between NASA and Delaware North Parks Services; self-supporting through sales of tickets, food and souvenirs. Florida's fifth most popular tourist attraction, and first among NASA field centers. Guided bus tours of KSC and CCAFS, films (including the wide screen IMAX movies), exhibits such as full-scale mockup of Space Station module, actual Saturn V moon rocket at Apollo Saturn V Center, educational and informational services, souvenir and food sales. Space Shuttle orbiter replica located on north side of visitor complex, and opportunity to come face to face with an astronaut every day. Open every day except December 25; opens at 9 a.m., closing time varies depending on time of year. Two attractions at KSCVC sponsored by non-profit duty: Astronaut Memorial, or Space Mirror, has engraved names of fallen American astronauts on movable granite surface 15.2 m (50 ft) wide and 13 m (42.5 ft) high; and Center for Space Education, a 4,088 m^2 (44,000 ft^2) educational facility.

Merritt Island National Wildlife Refuge and Canaveral National Seashore:

- *Refuge* — established 1963, managed by U.S. Fish and Wildlife Service on KSC land and water not used by NASA for space program. More than 500 wildlife species, of which 331 are birds; includes 21 species listed on federal and state threatened or endangered lists (ex., West Indian manatee, Florida scrub jay, loggerhead sea turtle and peregrine falcon). 6,000 ha (15,000 a) manatee sanctuary in northern end of Banana River, south of Launch Pad 39A; largest concentration of manatees on East Coast. Wildlife programs and exhibits, hiking, boating and fishing, wildlife photography; waterfowl hunting permitted in season in some areas. Visitor information center on State Road 402, 6.4 km (4 mi) east of Titusville. Three hiking trails, one 11.3 km (7 mi) wildlife drive and a manatee observation deck. Refuge open during daylight hours.

- *Seashore* — established 1975, co-located with refuge on section of undeveloped beach from north of Launch Pad 39B to south of New Smyrna. Swimming, surfing, surf fishing, crabbing, clamming and shrimping. Self-guided canoe trail and campsites, boat launching sites for access to Mosquito Lagoon and Indian River. Seashore headquarters, 308 Julia St., Titusville. Seashore hours 6 a.m. to 6 p.m. from last Sunday in October until

first Sunday in April; 6 a.m. to 8 p.m. for remainder of year. Refuge and seashore closed during Shuttle launch operations.

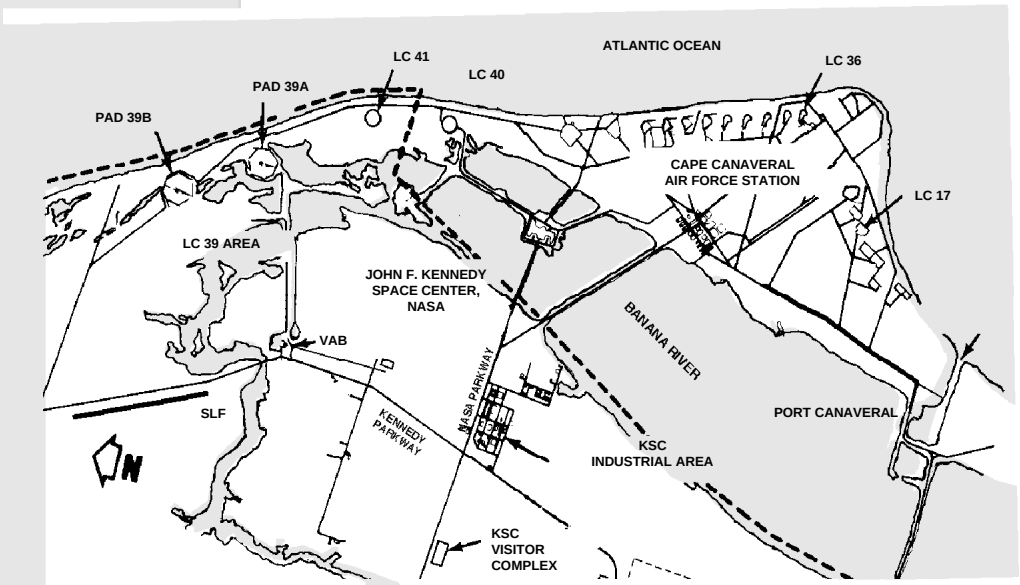
Orange groves: NASA leases 619.2 ha (1530 a) of orange groves to private companies. Generates average of $3 million - $4 million/year; proceeds go to general revenues. More than 60 apiary (bee) sites also leased.

Saturn V rocket: Full-scale test article for Apollo/Saturn V program; would have to be man-rated for flight. Housed in Apollo/Saturn V building at Banana Creek Viewing Site, off Kennedy Parkway North.

Cape Canaveral Air Force Station (CCAFS)

Located east of KSC on a barrier island fronting Atlantic Ocean, CCAFS is Station No. 1 of Eastern Range. The Eastern Range stretches for 15 million square terrestrial miles, from Canada to Africa to Bermuda and back:

- Purchase of CCAFS, which contains 6,396 ha (15,804 a), authorized by Congress on May 11, 1949.
- Presently CCAFS is part of 45th Space Wing, host organization for Eastern Range, which also includes Patrick Air Force Base, Antigua Air Station and Ascension Auxiliary Airfield tracking stations.
- Only unmanned Expendable Launch Vehicles (ELVs) launched from CCAFS; submarine launches of Trident missile conducted offshore using Range.
- NASA no longer controls ELV launches, but contracts with either U.S. Air Force or vehicle manufacturer for vehicle/launch service; NASA retains oversight responsibility for vehicles and launches carrying NASA payloads.


ATLANTIC OCEAN
LC 41
LC 40
LC 36
PAD 39A
PAD 39B
CAPE CANAVERAL
AIR FORCE STATION
LC 17
LC 39 AREA
JOHN F. KENNEDY
SPACE CENTER,
NASA
VAB
BANANA RIVER
SLF
NASA PARKWAY
KENNEDY
PARKWAY
PORT CANAVERAL
KSC
INDUSTRIAL AREA
N
KSC
VISITOR
COMPLEX

CCAFS Industrial Area

NASA, Air Force and contractor facilities for processing ELV hardware and payloads, Space Shuttle payloads and expended Shuttle solid rocket boosters (SRBs), are located in CCAFS Industrial Area.

Building AE (NASA): Spacecraft receiving and checkout facility. Management team in Mission Directors Center located here. Oversees launches of NASA, Air Force and commercial payloads on Delta and Atlas ELVs. Pre-launch data received via Launch Vehicle Data Center located here, liftoff and ascent data provided by Telemetry Facility here.

Building AO (NASA): Spacecraft receiving and checkout facility. Mission Operations Center for NASA spacecraft after separation from ELV and during early stages of flight; includes planetary explorers such as Mars Observer.

Central Computer Complex (Air Force): Processes tracking, communications, optics and telemetry data for all launch operations.

Hangar AF (NASA): Shuttle Solid Rocket Booster Disassembly Facility. Two ships tow expended boosters to AF for cleaning and disassembly. [See also Solid Rocket Booster Processing.]

Hangar L (NASA): Life Sciences Support Facility. Biological specimens for Shuttle payloads are received and processed at Hangar L. Facility also supports on-site scientific research projects, such as KSC Controlled Ecological Life Support System (CELSS) project investigating bioregenerative systems. [See also Payload Processing.]

SRB Retrieval Ships, Liberty Star and Freedom Star (NASA): 53.7 m (176 ft) long, 11.3 m (37 ft) across. Normal cruising speed 18.5 - 22.2 km/h (11.5 - 13.8 mi/h or 10 - 12 kn/h). Equipped with diesel-driven waterjet stern and bow thrusters to protect manatees from injury.

Other CCAFS Industrial Area Facilities

Building AM:	NASA (Spacecraft receiving and checkout)
E&L Building:	45th Operations Group and Logistics Group Headquarters, CCAFS
E&O Building:	NASA (ELV activities)
Hangar C:	USAF (Aerostat)
Hangar D:	USAF
Hangar E:	USAF (Inertial Upper Stage booster)
Hangar F:	USAF
Hangar H:	USAF
Hangar I:	USAF
Hangar J & K:	General Dynamics (Atlas-Centaur checkout)
Hangar M:	USAF (Delta receiving and storage)
Hangar N:	NASA (Shuttle SRB operations)
Hangar R:	USAF
Hangar S:	NASA (Spacecraft receiving and checkout; SCAPE suit storage)
Hangar T:	USAF
Hangar U:	USAF
Hangar Y:	Navy
Hangar AA:	USAF

Other CCAFS Facilities/Landmarks

Antenna Field (Air Force): North of South Patrol Road. Antennas of all sizes and shapes receive incoming communications from all Eastern Range stations, ships and aircraft; also round-the-world communications capability.

Burial sites: Graves of early settlers, including first permanent lighthouse keeper, located on Cape. Also three Indian burial sites on river side of Cape.

Cape Lighthouse: Original brick structure completed in 1847, first manned in 1853. Range of light is 30.6 km (19 mi). Lighthouse 50.3 m (165 ft) high, unmanned, computer-operated by U.S. Coast Guard. Also used as tower for Range Safety Search Radar Antenna.

Command Control Site (Air Force): Between Pier Road and Lighthouse Road. Transmit antennas located here are used by Range Safety to terminate a missile flight for reasons of safety.

Engineering Support Area-60A (NASA): North of CCAFS Industrial Area. One of two CCAFS facilities for performing hazard-

ous operations on ELV payloads, including mating spacecraft and upper stage booster, spacecraft fueling and payload encapsulation.

Fuel Storage Area No. 2: South of CCAFS Industrial Area, on Phillips Parkway. One of six ordnance storage areas on CCAFS. Solid propellant/ordnance stored here, ranging from small arms ammunition to apogee kick motors for boosting spacecraft into orbit.

High-Energy Radiographic Facility (SRM X-Ray Facility) (NASA contractor): On FSA 5 Rd. Non-destructive evaluation test lab. Has Linatron facility for X-ray of solid rocket motors.

Payload Spin Test Facility (Air Force): On Lighthouse Rd. Second of two CCAFS facilities for performing hazardous operations on Shuttle and ELV payloads such as spacecraft and upper stages, including installation of solid propellant apogee motors or ordnance separation devices and hydrazine loading.

Range Operations Control Center (Air Force): On south Phillips Parkway. Opened in 1990 and operational in 1994, it performs all range control functions including communications, range safety, weather, range control and scheduling, and other support services for all launches. The 11,798 m^2 (127,000 ft^2) facility will support one launch countdown and one non-launch activity simultaneously.

Skid Strip (USAF): A paved landing strip 3,048 m (10,000 ft) long. ELV and spacecraft elements delivered here. Departure site for Shuttle astronauts after end-of-mission KSC landing.

Central Telemetry Station known as Tel-4 (Air Force facility located on Merritt Island, in southern area of KSC): Central telemetry station for Eastern Range. Acquisition, storage and processing of telemetry data performed here, including during launches.

Port Canaveral: Deep-water port connects Atlantic Ocean with Banana and Indian Rivers. Serves as port for nuclear submarines used in Navy Trident missile launches and for instrumented ships of Eastern Range and NASA. Also used by Coast Guard vessels and commercial ships. Expended Shuttle boosters are brought through port to Hangar AF on CCAFS.

Launch Complexes and Vehicles – Active

Launch Complex 17 (Active)
Delta II & Delta III (Air Force and The Boeing Company)

LC 17 has two launch pads (A and B), one blockhouse, shops and other facilities for preparing, servicing and launching Delta II unmanned rocket:

- Service tower (gantry): 53 m (174 ft).
- Umbilical tower: 40.5 m (133 ft).
- Complex dimensions: East-west, 411.5 m (1,350 ft). North-south, 472.4 m (1,550 ft).

Three-stage Delta originally designed and developed for NASA by McDonnell Douglas. Launched for first time in May 1960; was NASA's most frequently launched medium-class vehicle. More technological applications and scientific spacecraft launched on Deltas than all other medium-class vehicles combined. All major U.S. weather satellite series launched on Delta. Most recent version of "Dependable Delta" is 7925 configuration of Delta II,

developed for Air Force and features nine strap-on solid propellant motors with graphite epoxy casings; six ignite at liftoff, and remaining three kick in one minute into ascent:

- *Liftoff height:* 38.1 m (125 ft).
- *Total vehicle weight (with solids):* 231,336 kg (510,000 lb).
- *Total thrust with six solids and first stage burning:* 3.01 million newtons (676,000 lb).
- *First stage:* Burns refined kerosene (RP-1) and liquid oxygen, producing 920,736 newtons (207,000 lb) of thrust. Each solid produces an average thrust of 471,933 newtons (106,100 lb).
- *Second stage:* Uses Aerozine-50 fuel and nitrogen tetroxide as oxidizer, maximum thrust is 43,590 newtons (9,800 lb).
- *Third stage:* Uses solid propellant, thrust is 75,616 newtons (17,000 lb).
- *Payload capability:* 1,814 kg (4,000 lb) of payload to geotransfer orbit.

Selected Launch History of Delta at LC 17

Payload	*Launch Date*	*Remarks*
Telstar 1 (NASA payload and launch)	July 10, 1962	First privately built satellite (AT&T). First TV transmission.
Syncom 2 (NASA payload launch)	July 26, 1963	First operational communications satellite in geosynchronous orbit and at 35,887 km (22,300 mi) altitude.
INTELSAT 1 (NASA payload and launch)	April 6, 1965	First international communications satellite (Early Bird).
Westar 1 (NASA payload and launch)	April 13, 1974	First U.S. domestic communications satellite.
SMS 1 (NASA payload and launch)	May 17, 1974	Synchronous Meteorological Satellite. First operational U.S.weather satellite in geosynchronous orbit.
SMM (NASA payload and launch)	Feb. 14, 1980	Solar Maximum Mission (SMM) to study Sun. First satellite retrieved and repaired in space, during

Payload	*Launch Date*	*Remarks*
		Space Shuttle Mission 41-C, April 1984. [See Selected Space Shuttle Launch History.]
Navstar GPS (USAF program and launch)	Feb. 14, 1989	First launch of Navstar Global Positioning System (GPS) satellite constellation deployment.
EUVE (NASA payload and USAF launch)	June 7, 1992	NASA's Extreme Ultraviolet Explorer (EUVE) became first satellite to study entire extreme ultraviolet (UV) region of light spectrum, and discovered new sources of extreme UV radiation.
Geotail (NASA payload and McDonnell Douglas launch)	July 24, 1992	Joint NASA-Japanese effort to study interactions between Sun, Earth's magnetic field and VanAllen radiation belt.
Wind Spacecraft (NASA payload and launch)	Nov. 1, 1994	A global geo-space science program designed to measure solar wind phenomenon.
X-Ray Timing Explorer (NASA payload and launch)	Dec. 30, 1995	Carried three instruments to gather data on X-ray sources such as white dwarfs and black holes.

Launch Complex 20 *(Active)*
Operated by Florida Spaceport Authority

The Spaceport Authority was created by Florida's Governor and Legislature in 1989 to retain, expand and diversify the state's space-related industry. Legislation establishing the state's space agency (Chapter 331, Part Two, F.S.) extended governmental powers similar to other types of transportation authorities (airport, seaport, etc.) to support and regulate the space transportation industry. The legislation also provided the Spaceport Authority with statewide responsibility for space-related economic and academic development.

As a transportation authority, the Spaceport Authority works closely with industry and other state and federal agencies on infrastructure projects for domestic and international space launch programs, including suborbital, expendable and reusable launch vehicles. In cooperation with NASA, the Air Force and the Navy, the Spaceport Authority develops a five-year transportation infrastructure plan for Cape Canaveral Spaceport, which is submitted to Florida Department of Transportation to support investment of state transportation funding.

Launch Complex 36 *(Active)*
(Air Force & Lockheed-Martin)

LC 36 built specifically to support launch of Atlas-Centaur unmanned rocket. Complex has two launch pads, one blockhouse, launch support building and other buildings and equipment. Pad 36B is commercial launch pad capable of supporting all Atlas configurations (Atlas I, II, IIA and IIAS). Pad 36A is military launch pad used for Atlas II launches:

- Service tower: 67.1 m (220 ft), 20 levels.
- Umbilical tower: 48.5 m (159 ft), 14 levels.
- Complex dimensions: East-west, 457.2 m (1,500 ft). North-south, 853.4 m (2,800 ft).

Atlas Family of Expendable Launch Vehicles

Atlas stage originally developed as Intercontinental Ballistic Missile and first launched in 1957. Latest growth version of Atlas/ Centaur combination is Atlas IIAS:

- Liftoff height: 49.4 m (162 ft).
- Total vehicle weight: 232,016 kg (511,500 lb).
- First stage (including four strap-ons): 3.03 million newtons (681,000 lb) of thrust.
- Centaur: 185,037 newtons (41,600 lb) of thrust.
- Payload capability: 3,833 kg (8,450 lb) to geotransfer orbit.

Selected Launch History of Atlas-Centaur at LC 36

Payload	*Launch Date*	*Remarks*
Surveyor 1 (NASA payload and launch)	May 30, 1966	First U.S. spacecraft to soft-land on Moon, in Ocean of Storms. Returned more than 10,000 high-quality images and selenogical data.
Mariner 9 (NASA payload and launch)	Nov. 28, 1971	First spacecraft to orbit another planet, Mars; mapped 85 percent of planet. Took first photos of moons Deimos and Phobos.
Pioneer 10 (NASA payload and launch)	March 2, 1972	First spacecraft to cross an asteroid belt. Completed first probe of Jupiter. Designed to have service life of less than two years. 258.6 kg (570 lb) spacecraft passed beyond planets in 1983 and is most distant human-made object in history, more than 8 billion km (5 billion mi) from Earth.
Pioneer 11 (NASA payload and launch)	April 5, 1973	Used pull of Jovian gravity to acquire new trajectory and become first spacecraft to visit Saturn, return photos and data.

Payload	*Launch Date*	*Remarks*
Pioneer Venus 1 (orbiter) (NASA payload and launch)	May 20, 1978	First spacecraft placed in orbit around Venus (Dec. 5, 1978). Operated until October 1992.
Pioneer Venus 2 (multiprobe) (NASA payload and launch)	Aug. 8, 1978	Dropped four probes to surface of Venus to gather data on atmosphere during descent. Venus encounter occurred on Dec. 9, 1978.

Launch Complex 37

Delta IV (The Boeing Company)

Complex 37 is being modified by The Boeing Company for Delta IV program. Boeing received Right of Entry from the Air Force on June 8, 1998, and work began on the complex June 28. Complex 37 consists of approximately 129 acres, and will include launch pad, Support Equipment Building (SEB) and Launch Support Shelter (LSS) for Delta IV. The blockhouse currently at Complex 37 is being refurbished as common support building.

Launch Complex 40 *(Active)*
Titan IV (U.S. Air Force)

The Titan launch complex is partly built on man-made islands in Banana River. The central processing site is the Integrated-Transfer-Launch (ITL) area:

- Vertical Integration Building (VIB): Titan core vehicle processed here. Buildings include Inertial Upper Stage (IUS) checkout station, Centaur stage processing cell, payload fairing processing annex, and payload fairing cleaning house.
- Solid Rocket Motor Assembly Building (SMAB): Solid rocket motors (SRMs) are stacked and mated to Titan core vehicle in SMAB. Also located here are Shuttle Payload Integration Facility and an IUS checkout room.
- Solid Rocket Motor Assembly and Readiness Facility (SMARF): SRMs and Solid Rocket Motor Upgrades (SRMU) processed, stacked and mated to Titan core in SMARF.

Family of Expendable Launch Vehicles

NASA combined Titan third stage and Centaur upper stage to form Titan-Centaur, which sent two Helios spacecraft to the Sun, two Viking explorers to Mars and two Voyagers to Jupiter and Saturn, one of which went on to Uranus and Neptune. Titan III, a commercial vehicle, and Titan IV, developed for Air Force but also used by NASA, are current versions. Titan IV is most powerful unmanned launcher made by U.S., can be flown with Centaur stage, Inertial Upper Stage or no upper stage:

- Liftoff height (Titan IV-Centaur): 61.0 m (200 ft).
- Total vehicle weight: 861,840 kg (1.9 million lb).
- Stage zero: Two solid rocket motor strap-ons 35.1 m (115 ft) tall and weighing 317,520 kg (700,000 lb) each ignite first, producing total liftoff thrust of 13.3 million newtons (3 million lb).
- First stage: Two engines powered by Aerozine 50 and nitrogen tetroxide produce thrust of 2.44 million newtons (548,000 lb). Ignites when stage zero burns out.
- Second stage: Burns Aerozine 50 and nitrogen tetroxide, producing total thrust of 458,144 newtons (103,000 lb).

- Centaur stage: Two engines, burning liquid hydrogen and liquid oxygen, yield total thrust of 146,784 newtons (33,000 lb).
- Payload capability: 17,690 kg (39,000 lb) to 185 km (115 mi) low Earth orbit; 4,536 kg (10,000 lb) to 35,887 km (22,300 mi) geosynchronous orbit.

Complex 41
Atlas V (Lockheed-Martin)

Under the Air Force's EELV program, Lockheed Martin received Right of Entry from Air Force in 1999 to begin construction on facility for its Atlas V heavy lift booster. The last Air Force Titan IV launched from Complex 41 lifted off the pad April 9, 1999. Lockheed Martin took control of facility following that launch. The company toppled existing Mobile Service Tower and Umbilical Tower on Oct. 14, 1999, and immediately began construction of new facilities. Lockheed simultaneously began construction on Vertical Integration Facility, approximately 2,500 feet from Complex 41. The first launch from Complex 41 is scheduled to take place in 2002.

Launch History of NASA Titan-Centaur at LC 41

Vehicle	Payload	Launch Date	Remarks
Titan-Centaur	Helios 1	Dec. 10,1974	Firsrt of two joint U.S.-West German probes to study Sun.
Titan-Centaur	Viking 1 Viking 2	Aug. 20, 1975 Sept. 9,1975	Twin-spacecraft search for microscopic life in Martian soil samples. First U.S. spacecraft to land on another planet. Found no positive indications of life.
Titan-Centaur	Helios 2	Jan 15, 1976	Traveled closer to Sun than any other man-made object. Penetrated to and studied fringes of outer solar corona.
Titan-Centaur	Voyager 2	Aug. 20, 1977	Flew closer to Saturn than Voyager 1. Completed first flyby of Uranus. Flew by Neptune in August 1989.

Vehicle	Payload	Launch Date	Remarks
Titan-Centaur	Voyager 1	Sept. 5, 1977	Closest Jupiter approach was March 5, 1979. Made close observations of Saturn and Titan in November 1980. Both Voyagers 1 and 2 have exited elliptic plane and are conducting field-and-particle experiments in search of boundary between heliosphere and interstellar space.

Launch Complex 46 *(Active)*
Athena I & II (Spaceport Florida)

Spaceport Florida was awarded grant in 1993 to modify LC 46 to accommodate small-class commercial launch vehicles with payload capability of up to approximately 1,814 kg (4,000 lb).

Launch Complex 47 *(Active)*
Meteorological Rocket Launch Facility (Air Force)

About 50 Super Loki meteorological sounding rockets launched from LC 47 each year to collect wind, temperature and density information from 18,288 to 91,440 m (60,000 to 300,000 ft) altitude. High-level wind data used by Range Safety.

Historical Launch Complexes/ Programs - CCAFS and KSC

This historical section details early manned and unmanned space programs and launch complexes on both CCAFS and KSC, and provides selected launch histories. Launch Complex 39 on KSC is only launch site mentioned in this section that is still active today.

Launch Complexes 1, 2, 3, and 4 *(CCAFS, Inactive)*

LC 3, east of LC 36, was site of first Cape launch on July 24, 1950. Vehicle was modified captured German V-2, with Army “WAC Corporal” second stage; called Bumper:

- Height: 14.3 m (47 ft). Propellants were alcohol and liquid oxygen.
- Diameter: 1.5 m (5 ft). Thrust: 266,880 newtons (60,000 lb).
- Weight: 12,805 kg (28,229 lb). Range: 354.1 km (220 mi).

Launch Complex 5/6 *(CCAFS, Dismantled) Mercury, 1961-1963 (NASA); U.S. Air Force Space Museum*

First NASA manned space flight program. Army's Redstone vehicle used for initial suborbital manned flights at LC 5/6. Program moved to LC 14 for orbital flights. Redstone service tower at LC 5/6 built in 1953 was first of its kind, operated on rails for greater mobility to and from vehicle; based on designs used in oil fields; allowed access to all levels and locations on vertically launched missile. Altogether 17 flights were conducted during Mercury, nine suborbital and eight orbital; six were manned and two carried chimpanzees (Ham and Enos):

- Mercury capsule: Weighed about 1,833 kg (4,040 lb); 2.1 m (7 ft) at base, 3.4 m (11 ft) long; 1 m^3 (36 ft^3) of habitable space.
- Mercury-Redstone vehicle: Height 18 m (59 ft); with capsule, 25 m (82 ft). Weighed 29,931 kg (65,986 lb). Propellants were liquid oxygen and RP-1; maximum liftoff thrust was 346,913 newtons (77,993 lb).

Along with adjacent LC 26, LC 5/6 is now site of Air Force Space Museum. [See Launch Complex 26 for more information.]

Launch History of Mercury-Redstone at LC 5/6

Capsule (Crew)	Launch Date	Remarks
Freedom 7 (Shepard)	May 5, 1961	Alan Shepard first American to be launched in rocket. Suborbital flight lasted 15 minutes, reached altitude of 186.7 km (116 mi), and traveled 486 km (302 mi) downrange.
Liberty Bell 7 (Grissom)	July 21, 1961	16-minute suborbital flight, similar to Freedom 7.

Launch Complex 12 *(CCAFS, Dismantled)*
Atlas-Agena

Ranger and Mariner scientific space probes launched on Atlas-Agenas from LC 12. First Atlas-Agena launched from LC 12 on January 10, 1958. Gantry razed in 1976 due to excessive rust. Altogether, 37 NASA and military launches conducted from LC 12.

Launch Complex 13 *(CCAFS, Inactive)*
Atlas-Agena

One Mariner and five Lunar Orbiter spacecraft launched from LC 13 on Atlas-Agena rockets. In 1966-1977, five Lunar Orbiters photographed 99 percent of the Moon's face and most of its dark side; images used to select lunar landing sites for Apollo. Mariner 3 was launched from LC 13 in November 1964; other Mariner series spacecraft lifted off from Launch Complexes 12 and 36.

Launch Complex 14 *(CCAFS, Dismantled)*
Mercury, 1961-1963 (NASA)

LC 14 was launch site for NASA manned Mercury orbital flights with Atlas vehicle. Pad used again later for Atlas-Agena launches when Agena stage became target vehicle for astronaut rendezvous practice in Gemini program:

- Mercury-Atlas vehicle: Height 22 m (72 ft). Diameter 3.1 m (10 ft). Launch weight 117,979 kg (260,095 lb). Produced 1.60 million newtons (359,968 lb) of thrust at liftoff; used liquid oxygen and RP-1. [See LC 5/6 for information on Mercury capsule.]

Launch History of Mercury-Atlas at LC 14

Vehicle/Capsule (Crew)	Launch/ Splashdown Dates	Remarks
Mercury-Atlas 6 Friendship 7 (Glenn)	Feb. 20/ Feb. 20, 1962	First manned U.S. orbital flight. Completed three orbits around Earth. Flight lasted four hours, 55 minutes.
Mercury-Atlas 7 Aurora 7 (Carpenter)	May 24/ May 24, 1962	Three orbits.
Mercury-Atlas 8 Sigma 7 (Schirra)	Oct. 3/ Oct. 3, 1962	Six orbits.
Mercury-Atlas 9 Faith 7 (Cooper)	May 15/ May 16, 1963	Twenty-two orbits.

Launch Complex 16 *(CCAFS, Inactive)*
Pershing II (Army)

Former test and launch site for Pershing II ballistic missile; subject to inspections under Intermediate Nuclear Forces Treaty.

Launch Complex 19 *(CCAFS, Deactivated)*
Project Gemini, 1965-1966 (NASA)

Project Gemini next step to Moon after Project Mercury. Gemini capsule launched on Air Force-developed Titan II vehicle. First two Gemini flights unmanned. Ten two-man crews launched from LC 19 over two-year period; for six of those flights, docking vehicles launched from LC 14, four on same day as Gemini at LC 19:

- Gemini capsule: Conical shape, 5.5 m (18 ft) high; 3 m (10 ft) diameter at base. Weighed 3,402 kg (7,500 lb) at liftoff. Contained 1.6 m^3 (55 ft^3) of habitable space (50 percent more than Mercury capsule).
- Titan vehicle: Height 33.2 m (109 ft) with Gemini capsule. Weighed 136,080 kg (300,000 lb). Propellants were unsymmetrical dimethylhydrazine (UDMH) and nitrogen tetroxide. Maximum liftoff thrust was 1.9 million newtons (430,000 lb).

Launch History of Gemini-Titan at LC 19

Vehicle/Capsule (Crew)	Launch/ Splashdown Dates	Remarks
Gemini-Titan 3 (Grissom, Young)	March 23/ March 23, 1965	Orbital maneuvers conducted. Last time crew named spacecraft ("Molly Brown") until Apollo.
Gemini-Titan 4 (McDivitt, White)	June 3/ June 7, 1965	Four-day flight, White performed first U. S. space walk.
Gemini-Titan 5 (Cooper, Conrad)	August 21/ August 29, 1965	Eight-day flight.
Gemini-Titan7 (Borman, Lovell)	Dec. 4/ Dec. 18, 1965	Long-duration flight nearly 14 days. Rendezvoused with manned Gemini 6A.
Gemini-Titan 6A (Schirra, Stafford)	Dec. 15/ Dec. 16, 1965	Used as rendezvous target for Gemini 7 after Gemini 6 target vehicle failed. (First launch attempt Dec. 12 ended with on-the-pad abort; crew did not eject.)
Gemini-Titan 8 (Armstrong, Scott)	March 16/ March 16, 1966	Launched same day as Agena Target Vehicle from LC 14. Docking of two spacecraft partially successful; mission ended early.

Vehicle/Capsule (Crew)	Launch/ Splashdown Dates	Remarks
Gemini-Titan 9A (Stafford, Cernan) (Original crew, Elliott See and Charles Bassett, killed in plane crash.)	June 3/ June 6, 1966	Planned docking with substitute target scrubbed when launch shroud failed to jettison.
Gemini-Titan 10 (Young, Collins)	July 18/ July 21, 1966	Docked with Agena. Launched same day from LC 14. Space walk.
Gemini-Titan 11 (Conrad, Gordon)	Sept. 12/ Sept. 15, 1966	Agena launched same day from LC 14. Space walk. High altitude orbit of 1,368 km (850 mi) reached.
Gemini-Titan 12 (Lovell, Aldrin)	Nov. 11/ Nov. 15, 1966	Agena launched same day from LC 14. Docking occurred. Space walk.

Launch Complex 26 *(Inactive)*
Explorer 1/Juno 1 (Army); U.S. Air Force Space and Missile Museum

Launch site for first U.S. satellite, Explorer 1, launched Jan. 31, 1958 aboard Juno 1 rocket by Army prior to formation of NASA. Satellite weighed 14.1 kg (31 lb), confirmed existence of Van Allen radiation belt. Along with adjacent LC 5/6, LC 26 is now site of USAF Space and Missile Museum, which features restored blockhouse and launch gantry, as well as 70 major exhibits. The Museum showcases only Navaho missile known to exist, as well as authentic hardware from other launch vehicles.

Launch Complexes 34 and 37 *(CCAFS, Dismantled)*
Launch Complex 39 *(KSC, Active)*
Project Apollo, 1960-1975 (NASA)

Three different launch vehicles used in Apollo, Saturn I, Saturn IB and Saturn V. Three different launch complexes involved, LC 34 and LC 37 on CCAFS and LC 39 on KSC. Only LC 39 still active. Altogether, 32 Saturn flights (seven from LC 34, eight from LC 37, and 17 from LC 39, including Skylab and Apollo-Soyuz Test Project) during Apollo era. Of 32 total, 15 were manned. Of seven attempted

lunar landing missions, six were successful. No major launch vehicle failures of either Saturn IB or Saturn V. There were two major command/service module failures, one on ground (Apollo 1) and one on way to Moon (Apollo 13):

- Apollo spacecraft
  - Command module carried three astronauts. Cone-shaped, 3.5 m (11 ft, 5 in) high; base diameter 3.9 m (12 ft, 10 in); habitable volume 6 m^3 (210 ft^3); approximate launch weight 5,829 kg (12,850 lb).
  - Service module was 7.5 m (24 ft, 7 in) high. Base diameter 3.9 m (12 ft, 10 in). Weighed about 24,528 kg (54,074 lb). Carried electrical power, environmental control and service propulsion system.
  - Lunar module was Moon-landing vehicle for two astronauts; 7 m (22 ft, 11 in) high; habitable volume 4.5 m^3 (160 ft^3). Weighed about 16,461 kg (36,289 lb) at liftoff. Carried inside spacecraft lunar module adapter, a tapered cylinder 8.5 m (28 ft) high.

Comparison of Saturn I, Saturn IB, and Saturn V Launch Vehicles

Criterion	Saturn I	Saturn IB	Saturn V
Total height	57.9 m (190 ft)	68.3 m (224 ft)	110.6 m (363 ft)
Total Weight	453,500 kg (999,780 lb)	589,550 kg (1,299,713 lb)	2,621,004 kg (5,778,228 lb)
First stage thrust	6,672,000 N (1,499,866 lb)	7,116,800 N (1,599,857 lb)	33,360,000 N (7,499,328 lb)
Second stage thrust	400,320 N (89,992 lb)	1,000,800 N (224,980 lb)	5,004,000 N (1,124,899 lb)
Third stage thrust	None	None	1,023,040 N (229,979 lb) (restart capability)
Payload capability	9,070 kg to 555 km Earth orbit (19,996 lb to 345 mi Earth orbit)	16,598 kg to 195 km Earth orbit (36,592 lb to 121 mi Earth orbit)	129,248 kg to 195 km Earth orbit (284,938 lb to 121 mi Earth orbit) 45,350 kg to escape trajectory (99,978 lb to escape trajectory)

N = newtons

Selected Launch History of Saturn I, IB, and V at LC 34, 37, and 39

Spacecraft Mission/Vehicle (Crew)	Pad	Launch/ Splashdown Dates	Remarks
Saturn I SA-1	34	Oct. 27, 1961	First launch of Saturn I.
Saturn I SA-7	37B	Sept. 18, 1964	Saturn I declared operational.
Saturn I SA-10	37B	July 30, 1965	Final Saturn I launch.
Saturn IB AS-201	34	Feb. 26, 1966	First Saturn IB launch. Suborbital test of Apollo command module heat shield.
Saturn IB Apollo 1/ AS-204 (Grissom, White, Chaffee)	34	Jan. 27, 1967	Prelaunch ground test took lives of astronauts Grissom, Chaffee and White. Later designated as Apollo 1, and upcoming maiden flight of Saturn V as Apollo 4. No Apollo 2 or 3 designated.

Spacecraft Mission/Vehicle (Crew)	Pad	Launch/ Splashdown Dates	Remarks
Saturn V Apollo 4/AS-501	39A	Nov. 9, 1967	First Saturn V launch. First LC 39 launch. Unmanned, all-up orbital test of Saturn V.
Saturn IB Apollo 7/AS-205 (Schirra, Eisele, Cunningham)	34	Oct. 11/ Oct. 22,1968	First manned Apollo launch. Peak Apollo program employment occurred at this time, with 26,000 workers supporting effort at KSC alone.
Saturn V Apollo 8/AS-503 (Borman, Lovell, Anders)	39A	Dec. 21/ Dec. 27, 1968	First manned flight to Moon. Orbited Moon 10 times.

Spacecraft Mission/Vehicle (Crew)	Pad	Launch/ Splashdown Dates	Remarks
Saturn V Apollo 9/AS-504 (McDivitt, Scott, Schweikart) Command module: Gumdrop Lunar module: Spider	39A	March 3/ March 13, 1969	Flight delayed three days because crew had mild colds. First flight of lunar module. Command/service module and lunar module named by crew. First docking of lunar module with command/service module.
Saturn V Apollo 10/AS-505 (Stafford, Young, Cernan) Command module: Charlie Brown; Lunar module: Snoppy	39B	May 18/ May 26, 1969	Lunar module flown to within 14,000 m (49,932 ft) of lunar surface.
Saturn V Apollo 11/AS-506 (Armstrong, Aldrin, Collins) Command module: Columbia; Lunar module: Eagle	39A	July 16/ July 24, 1969	Lunar landing occurred July 21 at 10:56 p.m. EDT. Armstrong and Aldrin spent 22 hours on lunar surface and collected 21 kg (46 lb) of lunar material.

Spacecraft Mission/Vehicle (Crew)	Pad	Launch/ Splashdown Dates	Remarks
Saturn V Apollo 12/AS-507 (Conrad, Gordon, Bean) Command module: Yankee Clipper Lunar module: Intrepid	39A	Nov. 14/ Nov. 24, 1969	Two lightning strikes to vehicle occurred during liftoff. Lunar module touched down 182 m (597 ft) from Surveyor 3 spacecraft launched in 1967.
Saturn V Apollo 13/AS-508 (Lovell, Swigert [replaced Mattingly], Haise) Command module: Odyssey Lunar module: Aquarius	39A	April 11/ April 17, 1970	Mission aborted 56 hours into flight following explosion in service module. Lunar module reconfigured to supply necessary power and other consumables for return trip to Earth after swing around Moon. Aquarius jettisoned; crew returned to Earth in command/service module.
Saturn V Apollo 14/AS-509 (Shepard, Roosa, Mitchell) Command module: Kitty Hawk Lunar module: Antares	39A	Jan. 31/ Feb. 9, 1971	Explored Frau Mauro region.

Spacecraft Mission/Vehicle (Crew)	Pad	Launch/ Splashdown Dates	Remarks
Saturn V Apollo 15/AS-510 (Scott, Worden, Irwin) Command module: Endeavour Lunar module: Falcon	39A	July 26/ Aug. 7, 1971	Final three Apollo flights emphasized scientific investigations. First use of Lunar Roving Vehicle. Studied Hadley-Apennine region.
Saturn V Apollo 16/AS-511 (Young, Mattingly, Duke) Commnand module: Casper Lunar module: Orion	39A	April 16/ April 27, 1972	Crew logged 27 km (17 miles) traveling on lunar surface. Problem with command/service module yaw actuator led to mission being shortened one day.
Saturn V Apollo 17/AS-512 (Cernan, Evans, Schmitt) Command module: America Lunar module: Challenger	39A	Dec. 7/ Dec. 19, 1972	First night launch (12:33 a.m. EST) of Saturn V. Final launch of Apollo lunar landing program. Estimated 500,000 people saw liftoff, visible from nearly 800 km (497 miles) away. Studied Taurus-Littrow region.

Skylab Space Station

Launch Complex 39 *(KSC, Active)*
Skylab – Space Station, 1973-1974 (NASA)

Early type of space station; was an application of Apollo program. Achieved several objectives: scientific investigations in Earth orbit (astronomical, space physics and biological experiments); applications in Earth orbit (Earth resources surveys); and long-duration spaceflight. Featured Skylab 1 orbital workshop inhabited in succession by three crews launched in modified Apollo command/service modules (Skylab 2, 3 and 4). Crews traveled 113.5 million km (70.5 million mi) and circled Earth 2,476 times, spending more than 3,000 hours conducting experiments. Data returned included 175,047 frames of solar observation film and 46,146 frames of Earth observation film. Actively used until February 1974, Skylab 1 remained in orbit much longer, until July 11, 1979, when it re-entered Earth atmosphere over Indian Ocean and western Australia.

Skylab 1 elements:

- Orbital Workshop (OWS): Modified third stage of Saturn V vehicle (S-IVB), contained about 283.2 m^3 (10,000 ft^3) of space; 14.6 m (48 ft) long and 6.7 m (22 ft) diameter. Weighed 35,381 kg (78,000 lb). Crew quarters, biomedical and engineering equipment located here.

- Airlock Module (AM): Provided pressurized passageway between OWS and Multiple Docking Adapter (MDA). Contained distribution center for power and environmental control systems. Habitable volume 17.0 m^3 (600 ft^3); length 5.2 m (17 ft); diameter 3.2 m (10 ft, 6 in); weight 22,226 kg (49,000 lb).
- Multiple Docking Adapter (MDA): Provided two docking ports for Command Service Module (CSM) and working space for controlling Apollo Telescope Mount (ATM), Earth resources experiments, and OWS attitude control system. Volume 32.3 m^3 (1,140 ft^3); weight 6,260 kg (13,800 lb); length 5.2 m (17 ft); outside diameter 3.3 m (10 ft, 6 in).
- Apollo Telescope Mount (ATM): Solar observatory containing eight telescopes that served seven solar experiments. In orbit, fixed 90 degrees from launch position; height 4.3 m (14 ft, 7 in); width 3.4 m (11 ft); weight 11,181 kg (24,650 lb); solar array span 29.9 m (98 ft).
- Payload Shroud (PS): Provided controlled environment for AM, MDA, and ATM during pad checkout operations and as aerodynamic enclosure during launch; jettisoned in orbit. Diameter 6.7 m (22 ft); length 23.2 m (76 ft); weight 11,794 kg (26,000 lb).

Skylab 2, 3 & 4 elements:

- Command Service Module (CSM): Modified Apollo CSM. Contained crew support system displays, control equipment required by crew, systems for Earth return and landing. Attached to MDA and remained in standby condition until return to Earth; approximate weight 14,062 kg (31,000 lb). Launched on Saturn IB from pedestal added to Mobile Launcher Platform from Pad B, Launch Complex 39, on Kennedy Space Center.

S-1B:

- First stage: Height 24.4 m (80 ft); diameter of thrust structure 7 m (23 ft), with fins 12.5 m (41 ft); fueled weight 452,297 kg (997,127 lb); dry weight 38,339 kg (84,521 lb); liftoff thrust 7.1 million N (1.6 million lb) from eight Rocketdyne H-1 engines; burn time about 2 minutes, 26 seconds; main engines were four stationary and four gimballed for directional control.
- Second stage: S-IVB, used as third stage of Saturn V.

History of Skylab Program

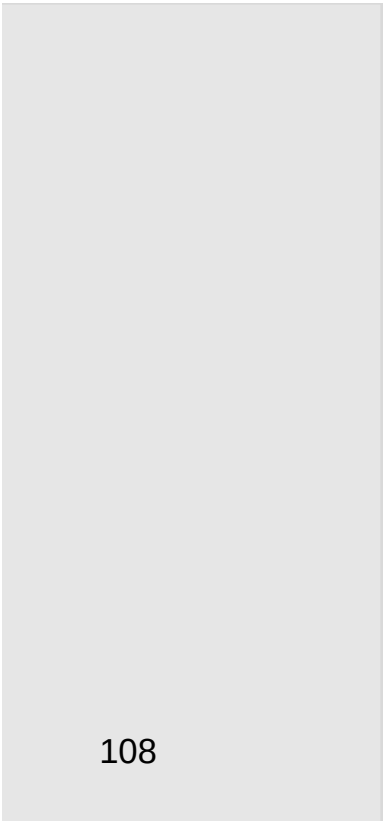
Spacecraft Mission/Vehicle (Crew)	Pad	Launch/ Splashdown Dates	Remarks
Saturn V Skylab 1/AS-513	39A	May 14, 1973	Included orbital workshop with crew quarters, Apollo telescope mount, solar observatory containing eight telescopes, and docking adapter with two docking ports for Apollo command/service modules. Meteoroid shield and one solar panel torn off and second solar panel jammed during launch, causing overheating inside orbital workshop and inadequate power.
Saturn 1B Skylab 2/AS-206 (Conrad, Kerwin, Weitz)	39B	May 25/ June 22, 1973	Crew deployed "parasol" to protect orbital workshop from Sun and freed jammed solar array. Remained on board Skylab for 28 days, 49 minutes.
Saturn 1B Skylab 3/AS-207 (Bean, Garriott, Lousma)	39B	July 28/ Sept. 25, 1973	Crew stayed on orbit 59 days, 11 hours.
Saturn 1B Skylab 4/AS-208 (Carr, Gibson, Pogue)	39B	Nov. 16, 1973/ Feb. 8, 1974	Crew in orbit 84 days, 1 hour.

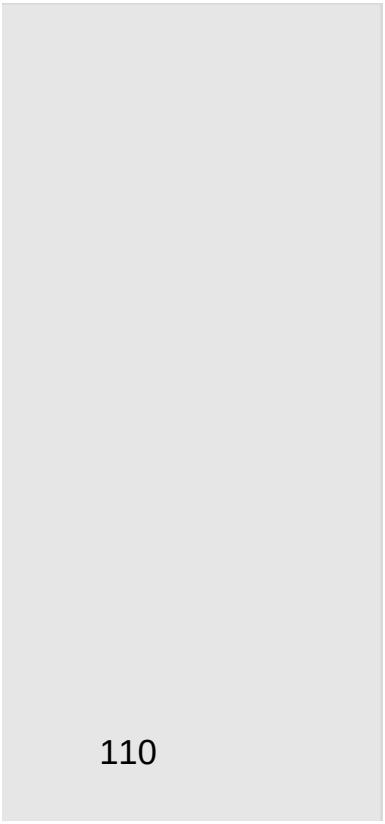
Launch Complex 39 *(KSC, Active)*
*Apollo–Soyuz Test Project (ASTP)**,** 1975 (NASA)*

First international rendezvous and docking in space; final application of Apollo program. Two spacecraft docked on July 17, 1975, and conducted two days of joint activities. After separation on July 21, Soyuz returned to Earth same day, followed by Apollo crew three days later.

Launch History of ASTP

Spacecraft Vehicle (Crew)	Pad	Launch/ Splashdown Dates	Remarks
Soyuz 19 Vostok 1 (Alexi Leonov, Valeriy Kubasov)	(Baikonur launch complex, Kazakhstan, Soviet Union)	July 15/ July 21, 1975	Soyuz crew lifted off about seven and a half hours before Apollo crew.
Saturn IB AS-210 (Stafford, Slayton, Brand)	39B	July 15/ July 24, 1975	Apollo command/service module with docking module attached liffed off from KSC, 10,461 km (6,500 mi) from Soviet launch complex.





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